UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

	)	
In the Matter of	)	Docket Nos.
	)	50-247-LR
Entergy Nuclear Operations, Inc.	)	and 50-286-LR
(Indian Point Nuclear Generating	)	
Units 2 and 3)	)	
	)	

RIVERKEEPER, INC. CONSOLIDATED MOTION FOR LEAVE TO FILE AMENDED CONTENTION RK-EC-8A AND AMENDED CONTENTION RK-EC-8A

Filed August 20, 2013

TABLE OF CONTENTS

LIST OF ATTACHMENTS

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos.
	)	50-247-LR
Entergy Nuclear Operations, Inc.	)	and 50-286-LR
(Indian Point Nuclear Generating	)	
Units 2 and 3)	)	August 20, 2013

RIVERKEEPER, INC. CONSOLIDATED MOTION FOR LEAVE TO FILE AMENDED CONTENTION RK-EC-8A AND AMENDED CONTENTION RK-EC-8A

In accordance with the Atomic Safety and Licensing Board's ("ASLB") Order dated July 9, 2013,[1] Riverkeeper Inc. ("Riverkeeper") hereby submits the following motion for leave to file Amended Contention RK-EC-8A, as well as Amended Contention RK-EC-8A, which is based on Supplement 1 to the U.S. Nuclear Regulatory Commission ("NRC") Staff's Final Supplemental Environmental Impact Statement ("FSEIS supplement"), issued on or about June 21, 2013 in the above-captioned Indian Point license renewal proceeding. This amended contention challenges NRC Staff's inadequate consideration of the impact of the proposed relicensing of the Indian Point nuclear power plant on endangered species in the Hudson River and NRC Staff's final recommendation concerning the appropriateness of relicensing Indian Point. In brief, Riverkeeper Amended Contention RK-EC-8A identifies NRC Staff's (1) failure to consider and respond to comments related to deficiencies in Endangered Species Act Section 7 consultations and the resulting inadequacies in NRC Staff's assessment of the impact of relicensing Indian Point on endangered aquatic resources, and (2) failure to revise or update its

[1] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (Establishing Deadline for Motions for New and Amended Contentions) (July 9, 2013), ADAMS Accession No. ML13190A063 ("[T]he Board directs that new or amended contentions arising from the recently published FSEIS Supplement will be considered timely if filed on or before August 20, 2013.").

recommendation on the appropriateness of renewing the operating licenses of Indian Point in light of NRC Staff's assessment of new information and circumstances in the FSEIS supplement.

BACKGROUND

On or about December 3, 2010, NRC Staff issued a Final Supplemental Environmental Impact Statement ("FSEIS") related to the proposed license renewal of the Indian Point nuclear power plant.[2] In accordance with established filing deadlines, on February 3, 2011, Riverkeeper filed a Consolidated Motion for Leave to File a New Contention and New Contention Concerning NRC Staff's Final Supplemental Environmental Impact Statement.[3] Riverkeeper's new contention, Contention RK-EC-8, challenged the analyses and conclusions contained in NRC Staff's FSEIS related to the impact of the continued operation of Indian Point on endangered aquatic resources in the Hudson River based upon NRC Staff's failure to commence or complete required consultation procedures pursuant to section 7 of the Federal Endangered Species Act ("ESA").[4] On July 6, 2011, the ASLB admitted Contention RK-EC-8, for adjudication in the Indian Point license renewal proceeding.[5]

Subsequent to the filing of Riverkeeper's Contention RK-EC-8, ESA § 7 consultation procedures between NRC Staff and the relevant Federal expert agency, the National Marine

---

[2] Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 (NUREG-1437, Supplement 38), Volumes 1-3, *available at*, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/supplement38/ (last visited Aug. 6, 2013) (hereinafter "December 2010 FSEIS"). In accordance with the ASLB's directive, Riverkeeper does not attach hereto copies of NRC Staff's draft or final FSEIS supplements related to the license renewal of Indian Point, or previously filed pleadings. *See* Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Scheduling Order (July 1, 2010) at ¶ M.2, ADAMS Accession No. ML101820387

[3] Riverkeeper, Inc. Consolidated Motion for Leave to File a New Contention and New Contention Concerning NRC Staff's Final Supplemental Environmental Impact Statement (February 3, 2011), ADAMS Accession No. ML110410362 (hereinafter cited as Riverkeeper New Contention RK-EC-8").

[4] *See generally id.*

[5] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (Ruling on Pending Motions for Leave to File New and Amended Contentions) (July 6, 2011), at 60-71, ADAMS Accession No. ML111870344.

Fisheries Service ("NMFS"), began. As part of this process, on or about August 26, 2011, NMFS issued a draft Biological Opinion ("BiOp") regarding the impact of the continued operation of Indian Point on endangered shortnose sturgeon in the Hudson River.[6] On September 15, 2011, Riverkeeper submitted comments to NMFS on this draft BiOp, pointing out several concerns regarding NMFS' analysis.[7] NMFS finalized its BiOp related to shortnose sturgeon on October 14, 2011.[8] However, after Atlantic sturgeon became officially listed as endangered under the ESA on February 6, 2012,[9] Section 7 consultation was reinitiated between NMFS and NRC Staff in relation to the license renewal of Indian Point.[10] Thus, on October 26, 2012, NMFS issued a new draft BiOp relating to the impacts of relicensing Indian Point on shortnose *and* Atlantic sturgeon in the Hudson River.[11] On November 23, 2012, Riverkeeper, once again, provided NMFS with comments on the new draft BiOp, identifying various ongoing concerns with NMFS' assessment and proposed conclusions.[12] NMFS finalized its new BiOp on or about January 30, 2013.[13]

[6] Endangered Species Act Section 7 Consultation Draft Biological Opinion, Nuclear Regulatory Commission, Relicensing – Indian Point Nuclear Generating Station F/NER/2009/00619 (Aug. 2011) (Attachment 1).
[7] Letter from D. Brancato (Riverkeeper) to P. Kurkul, J. Crocker, J. Williams (NMFS), Re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011) (Attachment 2).
[8] Endangered Species Act Section 7 Consultation Biological Opinion, Nuclear Regulatory Commission, Relicensing – Indian Point Nuclear Generating Station F/NER/2009/00619 (Oct. 14, 2011) (Attachment 3).
[9] *See* Final Rule, Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region, Part II, 77 Fed. Reg. 5880 (Feb. 6, 2012), *available at*, http://www.gpo.gov/fdsys/pkg/FR-2012-02-06/pdf/2012-1946.pdf (providing NMFS' final determination to list New York Bight and Chesapeake Bay Distinct Population Segments (DPSs) of Atlantic sturgeon as endangered species under the ESA).
[10] *See, e.g.*, NRC Staff's Status Report in Response to the Atomic Safety and Licensing Board's Order of February 16, 2012 (March 1, 2012), ADAMS Accession No. ML13060A449 (NMFS[] recently published a notice in the Federal Register, listing the Atlantic sturgeon as an endangered species under . . . ESA . . . . The Staff has initiated preliminary communications with NMFS concerning this matter, and expects to reinitiate consultations regarding this development under Section 7 of the ESA.").
[11] Endangered Species Act Section 7 Consultation Draft Biological Opinion, Nuclear Regulatory Commission, Continued Operations of the Indian Point Nuclear Generating Station F/NER/2012/02252 (Oct. 26, 2012) (Attachment 4).
[12] Letter from D. Brancato (Riverkeeper) to J. Bullard, J. Crocker, J. Williams (NMFS), Re: NMFS' 10/26/12 Draft Biological Opinion for Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (Nov. 23, 2012) (Attachment 5).
[13] Endangered Species Act Section 7 Consultation Biological Opinion, Nuclear Regulatory Commission, Continued Operations of the Indian Point Nuclear Generating Station, Units 2 and 3, pursuant to existing and proposed renewed

Also subsequent to the filing of Riverkeeper's Contention RK-EC-8, as well as after the commencement of the ESA § 7 consultation processes as discussed above, on or about November 30, 2011, NRC Staff decided to undertake a supplemental environmental review process related to the proposed license renewal of Indian Point.[14] This decision was based on the fact that NRC Staff had received, from Entergy, new and/or "corrected" information regarding impingement, entrainment, and thermal impacts to the aquatic ecology in the Hudson River caused by Indian Point, though NRC Staff indicated that the planned FSEIS supplement would also contain information regarding the ESA § 7 consultations and be relevant to Contention RK-EC-8.[15] In light of these circumstances, on December 14, 2011, the ASLB issued an order holding Contention RK-EC-8 "in abeyance" pending the outcome of the NRC Staff's supplemental environmental review process.[16]

---

operating licenses, NER-2012-2252 (Jan. 30, 2013) (hereinafter cited as "NMFS Jan. 30, 2013 Final BiOp") (Attachment 6).

[14] Letter from S. Turk (NRC) to Licensing Board (Nov. 30, 2011), ADAMS Accession No. ML11334A166 ("The Staff wishes to inform [the Board] that it has decided to issue a Supplement to the FSEIS for IP2 and IP3 (NUREG-1437, Supplement 38, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3," December 2010), in accordance with 10 C.F.R. § 51.92. The FSEIS Supplement will address new information which the Staff has received regarding aquatic impacts, including information received from NMFS and other interested parties. In this regard, the Staff expects to publish a draft Supplement for public comment in or about May 2012.").

[15] *See id.*; *see also* U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50-247 and 50-286 (June 2012) (hereinafter "Draft FSEIS Supplement"), at iii, ix, 1-2; In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (December 14, 2011), at 2, ADAMS Accession No. ML11348A032 (explaining NRC Staff's announcement that its draft supplement to the Indian Point FSEIS may address issues raised in Contention RK-EC-8).

[16] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (December 14, 2011), at 2, ADAMS Accession No. ML11348A032 ("[T]he initial evidentiary submissions of Riverkeeper relating to Contention RK-EC-8 are also held in abeyance pending further order of this Board in light of the Staff's announcement that a draft supplement to its Final Supplemental Environmental Impact Statement that addresses issues raised in this contention is expected to be issued."); *see also* In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (Granting NRC Staff's Unopposed Time Extension Motion and Directing Filing of Status Updates) (February 16, 2012), at 2, ADAMS Accession No. ML12047A308 ("Because of the current dynamic nature of the NRC Staff's uncompleted safety reviews, we place Contention NYS-25 on the second hearing track that already includes NYS-38/RK-TC-5 and RK-EC-8.").

NRC Staff issued a notice of availability and opportunity to comment on its planned draft supplement to the Indian Point FSEIS on June 26, 2012.[17] In accordance with the deadline established for public comment, on August 20, 2012, Riverkeeper submitted comments to the NRC relating to the draft FSEIS supplement.[18] Riverkeeper's comments identified, *inter alia*, concerns related to NRC Staff's consideration of the ESA § 7 consultation process and NRC Staff's conclusions regarding the impact of Indian Point on endangered aquatic resources in the Hudson River.[19] After the publication of NRC Staff's draft FSEIS supplement and after the stated comment period ended, as indicated above, on January 30, 2013, NMFS issued a Final BiOp concerning the proposed relicensing of Indian Point. On April 29, 2013, prior to NRC Staff's issuance of the final FSEIS supplement, Riverkeeper submitted supplemental comments to NRC that identified various concerns relating to NMFS' Final BiOp, for NRC Staff's consideration prior to any finalization of its supplemental environmental review process related to Indian Point.[20]

On or about June 21, 2013, over a year and a half after first announcing its intention to undertake a supplemental environmental review process, NRC Staff issued a final supplement,

---

[17] *See* Letter from David J. Wrona (NRC) to U.S. Environmental Protection Agency Office of Federal Activities NEPA Compliance Division EIS Filing Section, Re: Notice of Availability of Draft Supplement to Final Plant Specific Supplement 38 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 (June 26, 2012), ADAMS Accession No. ML12159A495 (indicating a comment period extending to August 20, 2012); *see also* Draft FSEIS Supplement.

[18] Letter From D. Brancato (Riverkeeper) to NRC Rules, Announcements, and Directives Branch Chief, Re: *Docket ID NRC-2008-0672*- Riverkeeper, Inc.'s Comments on the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50-247 and 50-286 (Aug. 20, 2012), ADAMS Accession No. ML12236A207 (hereinafter "Riverkeeper August 20, 2012 Comments on NRC Draft FSEIS Supplement") (Attachment 7).

[19] *Id.* at 6-12.

[20] Letter From D. Brancato (Riverkeeper) to NRC Rules, Announcements, and Directives Branch Chief, Re: *Docket ID NRC-2008-0672*- Riverkeeper, Inc.'s Supplemental Letter Regarding the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50-247 and 50-286 (April 29, 2013), ADAMS Accession No. ML13122A370 (hereinafter "Riverkeeper April 29, 2013 Supplemental Comments on NRC Draft FSEIS Supplement") (Attachment 8).

Supplement 1, to its Indian Point FSEIS.[21] The final FSEIS supplement contained a discussion of the ESA § 7 consultation processes and NMFS' Final BiOp related to proposed license renewal of Indian Point.[22] In accordance with ASLB directives, on July 1, 2013, Riverkeeper advised the ASLB that Riverkeeper intended to file an amendment to Contention RK-EC-8 in light of the information contained in NRC Staff's FSEIS supplement.[23] The ASLB thereafter, on July 9, 2013, issued an order setting August 20, 2013 as the deadline for filing new or amended contentions based upon information contained in NRC Staff's FSEIS supplement.[24] Amended contention RK-EC-8A, which addresses the new circumstances described above, and identifies ongoing deficiencies with NRC Staff's assessment of, and conclusions about, the impact of relicensing Indian Point on endangered species, follows forthwith.

RIVERKEEPER AMENDED CONTENTION RK-EC-8A: INADEQUATE CONSIDERATION OF IMPACTS TO ENDANGERED SPECIES

I. Specific Statement of Amended Contention RK-EC-8A Pursuant to 10 C.F.R. § 2.309(f)(1)(i)

10 C.F.R. § 2.309(f)(1)(i) requires that proffered contentions include "a specific statement of the issue of law or fact to be raised or controverted." Riverkeeper Amended

[21] *See* Letter from S. Turk (Counsel for NRC Staff) to ASLB (June 21, 2013); Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Supplement 38 Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 - Final Report Supplemental Report and Comment Responses (NUREG-1437, Supplement 38, Volume 4), *available at*, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/supplement38/v4/ (hereinafter cited as "Final FSEIS Supplement.").

[22] *See id.* at 23-30.

[23] Official Transcript of Proceedings, Nuclear Regulatory Commission, Entergy Nuclear Operations Indian Point Units 2 and 3, Docket Nos. 50-247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Monday June 10, 2013 Teleconference, Work Order No.: NRC-4280, Pages 4486-4559, at 4539 ("But what I would ask is for both New York and Riverkeeper within 10 days after the issuance of the supplement to the Environmental Impact Statement, if you notify the Board and the parties of a proposed schedule"); In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (Granting New York's Motions, Denying Clearwater's Motion, and Denying CZMA Motions) (June 12, 2013) ("Finally, the parties have 10 days after the publication of the forthcoming FSEIS to inform the Board whether 30 days will be sufficient time to file motions for new and amended contentions" (footnotes omitted)); *See* Letter from D. Brancato (Riverkeeper) to ASLB (July 1, 2013), ADAMS Accession No. ML13182A724 (advising ASLB about Riverkeeper intention to file an amendment to Contention RK-EC-8, and about the amount of time that Riverkeeper deemed necessary in order to do so).

[24] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (Establishing Deadline for Motions for New and Amended Contentions) (July 9, 2013), ADAMS Accession No. ML13190A063.

Contention EC-8A asserts the following: NRC Staff's FSEIS supplement pertaining to the license renewal of Indian Point is inadequate and, thus, violates the National Environmental Policy Act ("NEPA") because it (1) fails to properly consider or address Riverkeeper's comments regarding various deficiencies with NMFS' analyses and conclusions resulting from the ESA § 7 consultation process, and, in turn, fails to adequately assess impacts to endangered species posed by the potential relicensing of Indian Point, and (2) fails to explain how the new and significant information assessed by NRC Staff in the FSEIS supplement affect NRC Staff's recommendation to the Commission regarding the appropriateness of the proposed license renewal of Indian Point.

II. Explanation of Basis for Amended Contention RK-EC-8A Pursuant to 10 C.F.R. § 2.309(f)(1)(ii)

Riverkeeper hereby offers the following "brief explanation of the basis for the contention," in accordance with 10 C.F.R. § 2.309(f)(1)(ii):

A. NRC Staff's Supplemental Assessment of Endangered Species Impacts in the FSEIS Supplement is Inadequate Since NRC Staff Has Failed to Consider Critical Comments that are Material to NRC Staff's NEPA Review

The first basis for Riverkeeper Amended Contention RK-EC-8A is that, in relation to NRC Staff's supplemental assessment of endangered species impacts, NRC Staff's FSEIS supplement relies blindly on the analyses and conclusions contained in NMFS' final BiOp and fails to address or consider critical comments regarding numerous deficiencies in NMFS' analysis of how the ongoing and continued operation of Indian Point will impact endangered species. This failure violates basic tenets of NEPA and renders NRC Staff's assessment and conclusions in the FSEIS supplement relating to impacts to endangered species inadequate.

Riverkeeper's initial Contention RK-EC-8 articulated NRC Staff's unequivocal obligation to engage in and complete ESA § 7 consultations with NMFS, and to consider the outcome of that process in the context of NRC Staff's environmental review pursuant to NEPA of the proposed license renewal of Indian Point.[25] However, this is not an obligation to be followed blindly or as a matter of mere formality. Rather, NRC Staff's consideration of the ESA § 7 consultation process, as previously indicated, must be meaningful.[26] NRC Staff has demonstrably failed to undertake such a meaningful consideration. In particular, the ESA § 7 consultation process pertaining to the proposed license renewal of Indian Point resulted in a Final BiOp issued by NMFS that was riddled with inadequacies, which NRC Staff did not properly consider in the FSEIS supplement.

Riverkeeper affirmatively alerted NRC Staff to various concerns regarding the ESA § 7 consultations and NRC Staff failed to address such concerns in the FSEIS supplement.[27] First, Riverkeeper provided comments on NRC Staff's draft FSEIS supplement on August 20, 2012, within the established public comment period.[28] At the time of these comments, NMFS had already published a Final BiOp concerning shortnose sturgeon; however, consultations had been reinitiated, and were still ongoing, due to the official listing of Atlantic sturgeon as endangered.[29] Because the ESA § 7 consultations remained ongoing, Riverkeeper's comments focused on NRC Staff's continuing procedural failure to fully consider the consultation process in the context of

---

[25] Riverkeeper New Contention RK-EC-8; *see also* 10 C.F.R. § 51.95.

[26] *See* Riverkeeper New Contention RK-EC-8 at 5-7; *see also* 50 C.F.R. § 402.15 (only after the issuance of a BiOp can the Federal agency "determine whether and in what manner to proceed with the action in light of its section 7 obligations and the Service's biological opinion."); *Entergy Nuclear Generation Co. and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station), LBP-06-23, 64 NRC 257, 277 (2006) (explaining how NEPA requires that the decisionmaking agency "will carefully consider, detailed information concerning significant environmental impacts" (quoting *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989)); *Marsh v. Oregon Natural Resources Council*, 490 U.S. 360, 374 (1989) (An EIS must be searching and rigorous, providing a "hard look" at the environmental consequences of the agency's proposed action).

[27] Riverkeeper affirmatively engaged in commenting upon NMFS' draft biological opinions in the hopes of informing the end result, as discussed above. *See supra* at Background; *see also* Attachment 2, Attachment 5. However, various of these concerns remained unaddressed in NMFS' final biological opinions.

[28] *See* Riverkeeper August 20, 2012 Comments on NRC Draft FSEIS Supplement (Attachment 7).

[29] *See* Final FSEIS Supplement at §§ 4.2, 4.4 (explaining that NMFS issued a final BiOp concerning shortnose sturgeon on October 14, 2011, and the subsequent reinitiation of ESA § 7 consultation process in light of the listing of Atlantic sturgeon as endangered).

NRC Staff's NEPA review process. Thus, Riverkeeper's comments explained at length NRC Staff's obligation and failure to "meaningful[ly] consider" the ESA § 7 consultation process and any opinions and conclusions drawn by NMFS.[30] Notably, Riverkeeper could not comment fully on the adequacy of NMFS' Final BiOp in light of the ongoing nature of the ESA § 7 consultation process.

Nonetheless, Riverkeeper's comments incorporated a report generated by expert biologist consultants at Pisces Conservation Ltd ("Pisces"), and despite NRC Staff's reliance on and discussion of NMFS' then-final BiOp concerning shortnose sturgeon impacts in the draft FSEIS supplement, Pisces called into question NRC Staff's draft conclusions regarding allegedly "small" impacts to shortnose sturgeon from the ongoing operation of Indian Point. Pisces specifically indicated the need for more study and verification regarding impacts to shortnose sturgeon, in spite of NMFS' then-final BiOp regarding the species.[31] In addition, Riverkeeper continued to point out the problematic nature of relying on decades-old, obsolete, data in order to draw conclusions about impacts to endangered species.[32] Thus, Riverkeeper's initial comments on NRC Staff's draft FSEIS supplement did identify certain concerns with NRC Staff's dependence on NMFS' initial Final BiOp concerning shortnose sturgeon.

Next, *after* NMFS issued a Final BiOp concerning both shortnose *and* Atlantic sturgeon on or about January 30, 2013, but before NRC Staff issued a final FSEIS supplement, Riverkeeper submitted supplemental comments to NRC Staff on April 29, 2013 in order to articulate concerns relating to NMFS' final analyses and conclusions.[33] Riverkeeper's submission of these comments after the official public comment deadline, i.e., August 20, 2012,

[30] Riverkeeper August 20, 2012 Comments on NRC Draft FSEIS Supplement at 6-12 (Attachment 7).
[31] *Id.*
[32] *Id.*
[33] *See generally* Riverkeeper April 29, 2013 Supplemental Comments on NRC Draft FSEIS Supplement (Attachment 8).

was unavoidable since NMFS issued the Final BiOp, i.e. the subject of Riverkeeper's supplemental comments, on or about January 30, 2013, five months *after* the close of the public comment period.[34] Riverkeeper's comments indicated to NRC Staff Riverkeeper's position "that the issuance of NMFS' Final BiOp is" *not* "dispositive for purposes of NRC's conclusions regarding impacts to endangered species in the Indian Point FSEIS."[35] In particular, Riverkeeper's supplemental comments informed NRC Staff that "[f]or all the reasons explained at length in comments Riverkeeper submitted to NMFS on a draft of the BiOp . . . NMFS' assessment and conclusions, as ultimately memorialized in the Final BiOp, are questionable in light of the circumstances."[36]

Riverkeeper's April 29, 2013 supplemental comments to NRC appended and incorporated by reference the comments Riverkeeper previously submitted to NMFS, which identified several concerns regarding NMFS' BiOp, including the following: (1) NMFS' Final BiOp focused only on potential impacts of ongoing operations of Indian Point on endangered aquatic resources *as the plant currently operates*, even though Entergy is currently proposing to operate the plant with the operation of a cylindrical wedgewire screen technology, the impacts of which have not been assessed by NMFS or NRC Staff at all at Indian Point and which may have significantly different impacts on endangered species in the Hudson River; (2) NMFS' Final BiOp recognizes that the operation of Indian Point with once-through cooling water technology will adversely affect both endangered shortnose and Atlantic sturgeon, yet allows the take of hundreds of both of these species in the Hudson River, which is not trivial and may have

[34] *See* Letter from David J. Wrona (NRC) to U.S. Environmental Protection Agency Office of Federal Activities NEPA Compliance Division EIS Filing Section, Re: Notice of Availability of Draft Supplement to Final Plant Specific Supplement 38 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 (June 26, 2012), ADAMS Accession No. ML12159A495 (indicating a comment period extending to August 20, 2012); NMFS Jan. 30, 2013 Final BiOp (Attachment 6).
[35] Riverkeeper April 29, 2013 Supplemental Comments on NRC Draft FSEIS Supplement at 2 (Attachment 8).
[36] *Id.*

noticeable adverse affects on these species; (3) NMFS' Final BiOp failed to adequately assess the cumulative impacts to endangered aquatic species in view of sturgeon losses over all power plant water-intake structures; (4) NMFS' Final BiOp failed to adequately consider impacts of accidental radiological releases from Indian Point on endangered sturgeon; (5) NMFS' Final BiOp failed to assess all reasonable and prudent measures that may minimize impacts of Indian Point on endangered species, including the availability of alternative cooling water intake technology, closed-cycle cooling, that would substantially reduce the impacts to sturgeon caused by Indian Point; and (6) NMFS' Final BiOp included conservation recommendations that fail to assure a net conservation benefit to endangered sturgeon populations in the Hudson River.[37] These comments were supported by an expert report from Pisces.[38]

Notably, via letter dated March 25, 2013, the New York State Department of Environmental Conservation ("NYSDEC"), i.e., "the agency responsible for administering provisions of the ESA in New York pursuant to an agreement with NMFS under Section 6(c)(1) of the ESA," also submitted its concerns to the NRC regarding various deficiencies with NMFS' January 30, 2013 Final BiOp, prior to NRC Staff's issuance of the final FSEIS supplement.[39] NYSDEC's concerns substantiate and confirm various of the concerns raised by Riverkeeper explained above. In particular, NYSDEC informed NRC of the following: (1) because the continued operation of Indian Point Units 2 and 3 in once-through cooling mode does not meet state water quality standards, an incidental take exemption is entirely inappropriate; (2) NMFS' inappropriately failed to consult with NYSDEC prior to issuing its January 30, 2013 Final BiOp, despite NYSDEC's regulatory authority over relevant matters; (3) NMFS' incidental take

[37] Riverkeeper April 29, 2013 Supplemental Comments on NRC Draft FSEIS Supplement at Attachment 1 (Attachment 8).
[38] *Id.* at Attachment 1 to Attachment 1 (Attachment 8).
[39] Letter from K. Moser (NYSDEC) to A. Hull (NRC) Re: NMFS' January 30, 2013 Biological Opinion for Continued Operation of Indian Point Nuclear Generating Unit Nos. 2 and 3 (March 25, 2013) (Attachment 9). (hereinafter "NYSDEC March 25, 2013 Letter to NRC (Attachment 9)").

exemption was unjustified and "largely inflated by an unsupported assumption" regarding a water use correction factor; (4) NMFS' Final BiOp was inconsistent with NMFS' previous determination that the continued operation of Indian Point would have "significant impacts on Essential Fish Habitat" and NMFS' recommendation that NRC require closed-cycle cooling at Indian Point for future operations; (5) NMFS' Final BiOp inappropriately accepted anticipated sturgeon mortality as "unavoidable loss" and improperly failed to require or recommend *any* mitigation measures to "genuinely reduce or minimize incidental take of sturgeon"; and (6) NMFS inappropriately relied on "decades old" data to exempt the take of hundreds of Atlantic sturgeon.[40] Based on these concerns, NYSDEC indicated to NRC that NMFS' Final BiOp should be "rescinded, reconsidered, and modified."[41]

The foregoing establishes that various well-founded concerns were raised to NRC Staff relating to the validity and adequacy of NMFS' Final BiOp. However, NRC Staff's final FSEIS supplement fails to address these concerns, and instead relies, without reservation, on NMFS' Final BiOp to justify its conclusions in the final FSEIS supplement.[42] To begin with, in relation

[40] *Id.* at 1-6. NRC and NMFS both responded to NYSDEC via letters dated July 3, 2013 and May 31, 2013, respectively. *See* Letter from M. Wong (NRC) to K. Moser (NYSDEC), Re: National Marine Fisheries Service' Biological Opinion for Continued Operation of Indian Point Nuclear Generating Unit Nos. 2 and 3 (July 3, 2013), ADAMS Accession No. ML13123A275; Letter from K. Bullard (NMFS) to K. Moser (NYSDEC) (May 31, 2013), ADAMS Accession No. ML13155A475. However, these responses are not dispositive and don't negate the valid concerns raised by NYSDEC.

[41] NYSDEC March 25, 2013 Letter to NRC (Attachment 9), at 1.

[42] Riverkeeper's initial Contention RK-EC-8 explained NRC Staff's NEPA obligation to consider impacts to endangered species. In particular, the contention explained how renewing the operating license of a nuclear power plant is an action that triggers the NEPA requirement for a comprehensive environmental review and preparation of an environmental impact statement (*see* 10 C.F.R. § 51.1), how NRC employs a Generic Environmental Impact Statement which (1) contains generic analyses of various "Category 1" issues that are applicable during all license renewal proceedings, and (2) delineates certain "Category 2" issues that require site specific review during individual license renewal proceedings (*see* 10 C.F.R. Part 51, Table B-1 of Appendix B to Subpart A; NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants), and how the impacts of license renewal on threatened or endangered species is a "Category 2" issue that requires such site specific review during individual relicensing proceedings. *See* 10 C.F.R. Part 51, Table B-1 of Appendix B to Subpart A; NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants ("GEIS") § 3.9 ("Because compliance with the Endangered Species Act cannot be assessed without site-specific consideration of potential effects on threatened and endangered species, it is not possible to determine generically the significance of potential impacts to threatened and endangered species. This is a Category 2 issue.").

to Riverkeeper's August 20, 2012 comments on NRC Staff's draft FSEIS supplement, in response to the whole of Riverkeeper's comments related to ESA § 7 consultations, NRC Staff repeatedly responded only that

> [t]he staff addressed this comment in Section 4.0 of this supplement to the FSEIS, which has been revised to reflect the completion of consultations with NMFS on endangered species (including both shortnose sturgeon and Atlantic sturgeon), NMFS's biological opinion, and its issuance of an Incidental Take Statement for Indian Point Units 2 and 3.[43]

In no way did this address Riverkeeper's concerns regarding the adequacy of the ESA § 7 consultation process, or Riverkeeper's position, as more fully explained in Riverkeeper's later April 29, 2013 comments, that NRC Staff was obligated to, but failed to *meaningfully* consider NMFS' Final BiOp in light of relevant deficiencies in NMFS' analysis and conclusions. In fact, NRC Staff failed to even include in the final FSEIS supplement the various appendices that were attached to Riverkeeper's August 20, 2012 comments to NRC. As explained above, one such attachment, a report from Pisces, articulated concerns related to NRC Staff's conclusions about impacts to shortnose sturgeon, for which NRC Staff relied on the then-final BiOp related to that species.[44]

In addition, NRC Staff failed to even acknowledge receipt of or append, let alone consider and address, Riverkeeper's April 29, 2013 supplemental comments to NRC, which expressed critical concerns regarding the appropriateness of relying on NMFS' January 30, 2013 Final BiOp.[45] NRC Staff likewise did not acknowledge or address the concerns raised in NYSDEC's March 25, 2013 letter to NRC regarding various deficiencies in NMFS' Final

[43] Final FSEIS Supplement at A-8 to A-14.
[44] *See* Riverkeeper August 20, 2012 Comments on NRC Draft FSEIS Supplement at Attachment A (Attachment 7).
[45] *See* Final FSEIS Supplement Appendix A.

BiOp.[46] Despite that fact that these comments were submitted to NRC after the public comment period ended, it was entirely appropriate, indeed necessary, for NRC Staff to consider and address the issues raised in these comments.

First, the only reason such comments were not submitted within the comment period was because they addressed circumstances that occurred *after* the close of the comment period, i.e., NMFS' issuance of a Final BiOp on January 30, 2013. Moreover, given the important and highly relevant subject matter of these comments, the fact that one of the purported main focuses of NRC Staff's supplemental review process was squarely about the ESA § 7 consultation process,[47] and the length of time NRC Staff had already allegedly dedicated to preparing the FSEIS supplement,[48] there was simply no logical reason why NRC Staff should have ignored the critical concerns raised by Riverkeeper, as well as NYSDEC. Indeed, NRC has regularly indicated, including in relation to NRC Staff's draft FSEIS supplement concerning Indian Point, that it is explicitly willing to consider comments after an established deadline "if it is practical to do so."[49] In this instance, for the reasons stated above, it was entirely "practical," and, in fact advisable and necessary, for NRC Staff to consider Riverkeeper's supplemental comments.

NRC Staff's failure to address Riverkeeper's, as well as NYSDEC's, concerns and comments related to the inadequacy of NMFS's analyses and conclusions contained in the January 30, 2013 Final BiOp, and to discuss and adjust its assessment of endangered species

---

[46] *See id.*
[47] *See id.* at ix, 1-2, 23-30.
[48] On or about November 30, 2011, NRC Staff decided to undertake a supplemental environmental review process related to the proposed license renewal of Indian Point. Letter from S. Turk (NRC) to Licensing Board (Nov. 30, 2011), ADAMS Accession No. ML11334A166. NRC Staff did not publish the final planned FSEIS until over a year and a half later, on or about approximately June 21, 2013. Letter from S. Turk (Counsel for NRC Staff) to ASLB (June 21, 2013); *see also* Final FSEIS Supplement.
[49] *See* Notice of Availability, Draft Supplement To Supplement 38 To The Generic Environmental Impact Statement For License Renewal Of Nuclear Plants, 77 Fed. Reg. 40,091, 40,091-92 (July 6, 2013), *available at*, https://www.federalregister.gov/articles/2012/07/06/2012-16548/entergy-nuclear-operations-inc-indian-point-nuclear-generating-units-2-and-3 ("Submit comments by August 20, 2012. Comments received after this date will be considered if it is practical to do so.").

impacts in the final FSEIS accordingly, violates basic tenets of NEPA and renders NRC Staff's environmental review process pertaining to the proposed license renewal of Indian Point inadequate. NEPA seeks to ensure "a fully informed and well-considered decision."[50] An environmental impact statement prepared pursuant to NEPA must be searching and rigorous, providing a "hard look" at the environmental consequences of the agency's proposed action.[51] This process affirmatively involves meaningfully responding to comments and concerns received from the public.[52] The reviewing agency must also attach "[a]ll substantive comments received on the draft statement (or summaries thereof . . .) . . . whether or not the comment is thought to merit individual discussion by the agency."[53]

It is impossible to conclude that NRC Staff's final determinations related to endangered species impacts in the final FSEIS supplement were "fully-informed" and based on the requisite "hard look," when they have not considered the expert and State supported concerns identified by Riverkeeper in NEPA comments about NMFS' Final BiOp. Issuing a final FSEIS supplement that does not address the various deficiencies with NMFS' Final BiOp identified by

[50] *Vermont Yankee Nuclear Power Corp. V. Natural Resources Defense Council*, 435 U.S. 519, 558 (1978); *see also Entergy Nuclear Generation Co. and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station), LBP-06-23, 64 NRC 257, 277 (2006), quoting *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989) (The fundamental purpose of NEPA is to "ensure[] that the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts"); *Nw. Envtl. Advocates v. NMFS*, 2005 U.S. Dist. LEXIS 41828, *6 (W.D. Wash. 2005) ("The processes established under NEPA focus the attention of both the government and the public on a proposed agency action, so that the environmental consequences can be studied prior to implementation of the proposed action, and so potential negative impacts can be avoided") (citing 40 C.F.R. § 1500.1(b); 40 C.F.R. § 1500.2(e); *Marsh*, 490 U.S. at 371 (1989); *Churchill County v. Norton*, 276 F.3d 1060, 1072-73 (9th Cir. 2001)).
[51] *Marsh*, 490 U.S. at 374.
[52] 40 C.F.R. § 1502.9(a), (b) ("The lead agency shall work with the cooperating agencies and shall obtain comments . . . . Final environmental impact statements shall respond to comments as required"); 40 C.F.R. § 1503.4(a) ("An agency preparing a final environmental impact statement shall assess and consider comments both individually and collectively, and shall respond by one or more of the means listed below, stating its response in the final statement. Possible responses are to: (1) Modify alternatives including the proposed action. (2) Develop and evaluate alternatives not previously given serious consideration by the agency. (3) Supplement, improve, or modify its analyses. (4) Make factual corrections. (5) Explain why the comments do not warrant further agency response, citing the sources, authorities, or reasons which support the agency's position and, if appropriate, indicate those circumstances which would trigger agency reappraisal or further response.").
[53] 40 C.F.R. § 1503.4(b).

Riverkeeper effectively ensures that NRC Staff's determinations regarding impacts to endangered species and the license renewal of Indian Point are unfounded and inadequate, and completely flouts the purpose of the NEPA review and public comment process. Moreover, NRC Staff failed to even append Riverkeeper's April 29, 2013 comments, or the attachments to Riverkeeper's initial August 20, 2012 comments, in violation of federal regulations.[54]

NRC Staff's failure to acknowledge, address, or consider Riverkeeper's NEPA comments related to the adequacy of NMFS' Final BiOp has resulted in an FSEIS that does not adequately take into account adverse impacts on endangered species. NRC Staff's assessment and conclusions in the FSEIS in relation to impacts to endangered aquatic species lack proper foundation and remain flawed and patently deficient.

B. NRC Staff's FSEIS Supplement is Inadequate Since NRC Staff Has Failed to Indicate How the New and Significant Information Discussed in the FSEIS Supplement Affects NRC Staff's Recommendation to the Commission Regarding the Appropriateness of Relicensing Indian Point

A second basis for Riverkeeper Amended Contention RK-EC-8A is that the FSEIS supplement fails to comply with NRC regulations at 10 C.F.R. § 51.95(c)(4), which require NRC Staff to make an integrated and fully informed recommendation to the Commission regarding the "environmental acceptability" of renewing the operating licenses of Indian Point. In particular, the FSEIS supplement does not contain this required recommendation, and does not explain if or how the new and significant information assessed by NRC Staff in the FSEIS supplement, including NRC Staff's alleged assessment of endangered species impacts in light of NMFS' final BiOp, change or otherwise inform the initial recommendation made in NRC Staff's initial, i.e., December 2010, FSEIS.

[54] 40 C.F.R. § 1503.4(b).

10 C.F.R. § 51.95(c)(4) provides that a "supplemental environmental impact statement must contain the NRC staff's recommendation regarding the environmental acceptability of the license renewal action" and that

> [i]n order to make recommendations and reach a final decision on the proposed action, the NRC staff . . . *shall integrate the conclusions in the generic environmental impact statement for issues designated as Category 1 with information developed for those Category 2 issues applicable to the plant under § 51.53(c)(3)(ii) and any new and significant information*. Given this information, the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.[55]

As the ASLB in this proceeding has explained, "the FSEIS's essential 'final analysis and a final recommendation on the action to be taken' must play a fundamental role in the agency's decision in this proceeding on Entergy's LRA."[56] However, NRC Staff has demonstrably failed to comply with this requirement, since the FSEIS supplement did not include any updated or revised "recommendation" to the Commission regarding the acceptability of relicensing Indian Point in light of the newly analyzed information.

The FSEIS supplement explicitly indicates that NRC Staff undertook a supplemental NEPA analysis because "the staff identified *new* information that necessitated changes to its assessments in the FSEIS."[57] This alleged new information related to entrainment, impingement, and thermal impacts on aquatic ecology in the Hudson River.[58] In addition, the FSEIS supplement included NRC Staff's "documentation" of the Section 7 consultation with NMFS,

---

[55] 10 C.F.R. § 51.95(c)(4) (emphasis added).
[56] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (Ruling on Pending Motions for Leave to File New and Amended Contentions) (July 6, 2011), at 70, ADAMS Accession No. ML111870344 (citations omitted).
[57] Final FSEIS Supplement at ix (emphasis added).
[58] *See id.*

which in this case is part of the assessment of impacts to endangered species that NRC Staff is required to undertake as a Category 2, i.e., site-specific issue.[59] NRC Staff, thus, prepared the FSEIS supplement "[t]o address this new information" as well as to "document the completion of the consultation process under Section 7 of the Endangered Species Act."[60] While NRC Staff discussed its new assessment of aquatic impacts and the ESA § 7 consultation process, the FSEIS supplement does not contain any discussion or explanation of how such new assessments affect NRC Staff's earlier recommendation for the license renewal of Indian Point in NRC Staff's December 2010 FSEIS.[61]

This omission violates essential principles of NEPA and NRC implementing regulatory requirements: it is patent that, because this FSEIS supplement is an addition to the FSEIS that contains new impact analyses and conclusions, NRC Staff must explain how it incorporated these new assessments into its overall analysis and recommendation on whether to renew the operating licenses of Indian Point or not.[62] NRC Staff clearly cannot simply rely on its initial recommendation included in the 2010 FSEIS, since that document did not reflect NRC Staff's consideration of concededly *new* information and circumstances, relating to impacts on aquatic ecology of, and endangered species in, the Hudson River.[63]

In sum, NRC Staff's failure to update its recommendation on license renewal in light of NRC Staff's assessment of new information and circumstances violates NRC Staff's obligation under NEPA to take a "hard look" at the consequences of relicensing Indian Point and provide the decisionmakers, i.e., the Commission, with all the information necessary for said

---

[59] *See id.*; 10 C.F.R. Part 51, Table B-1 of Appendix B to Subpart A; NUREG-1437, GEIS § 3.9.
[60] Final FSEIS Supplement at ix.
[61] *See generally id.*
[62] 10 C.F.R. § 51.95(c)(4).
[63] *See generally* December 2010 FSEIS; *cf.* Final FSEIS Supplement.

decisionmakers to make an informed decision on whether to relicense Indian Point.[64] As the final step in the NEPA review process according to NRC regulations, it is clear that without a discussion of NRC Staff's recommendation on license renewal, NRC Staff's NEPA review is incomplete and fails to comply with NEPA and NRC implementing regulations.[65]

III. Amended Contention RK-EC-8A is Within the Scope of the Proceeding Pursuant to 10 C.F.R. § 2.309(f)(1)(iii)

Riverkeeper Amended Contention EC-8A is squarely within the scope of the Indian Point license renewal proceeding, in accordance with 10 C.F.R. § 2.309(f)(1)(iii). First, the amended contention challenges the adequacy of NRC Staff's assessment of the environmental impacts of the continued operation of Indian Point on endangered species in the Hudson River, in light of NRC Staff's failure to fully consider various deficiencies in the ESA § 7 consultation process and NMFS' analyses and conclusions stemming therefrom. NRC regulations state that the impacts of license renewal on threatened or endangered species is a "Category 2" issue that requires site-specific review during individual license renewal proceedings.[66] The amended contention questions the adequacy of NRC Staff's compliance with this requirement, and, thus, falls clearly within the scope of the instant proceeding.

Second, the contention questions the sufficiency of NRC Staff's NEPA review in light of NRC Staff's failure to provide an explanation of how the new assessments and conclusions in the FSEIS supplement affect NRC Staff's overall recommendations on the appropriateness of relicensing Indian Point. Since NRC Staff is unequivocally required to justify and base its final

---

[64] *Marsh*, 490 U.S. at 374; 10 C.F.R. § 51.95(c)(4).
[65] 10 C.F.R. § 51.95(c)(4).
[66] *See* 10 C.F.R. Part 51, Table B-1 of Appendix B to Subpart A; NUREG-1437, GEIS § 3.9 ("Because compliance with the Endangered Species Act cannot be assessed without site-specific consideration of potential effects on threatened and endangered species, it is not possible to determine generically the significance of potential impacts to threatened and endangered species. This is a Category 2 issue.").

recommendations on all of its analyses and conclusions,[67] the amended contention, which raises NRC Staff's failure to do so, falls precisely within the scope of the proceeding.

IV. Amended Contention RK-EC-8A is Material Pursuant to 10 C.F.R. § 2.309(f)(1)(iv)

The "issue raised in the contention is material to the findings NRC must make to support the action that is involved in the proceeding," in accordance with 10 C.F.R. § 2.309(f)(1)(iv). First, NRC must ascertain the site-specific environmental impacts of license renewal on endangered species.[68] This assessment is necessary for NRC Staff to make informed conclusions in the FSEIS, and, in turn, informed recommendations regarding the appropriateness of relicensing Indian Point.[69] Riverkeeper's Amended Contention EC-8A is, thus, material, since it demonstrates that NRC Staff's assessment and conclusions are deficient absent consideration of Riverkeeper and NYSDEC's comments regarding various deficiencies in the ESA § 7 consultation process. Without such consideration, NRC Staff's assessment of endangered species impacts in the FSEIS, and conclusions regarding the proposal to relicensing Indian Point, are without adequate basis. If the NRC renews Indian Point's operating licenses without fully satisfying NEPA, and Indian Point continues to operate with a once-through cooling water intake structure, the plant's operation could continue to have significant adverse impacts on endangered aquatic species during Entergy's proposed twenty-year license extension periods, possibly leading to jeopardizing the continued existence of Atlantic and shortnose sturgeon.[70]

Further, NRC Staff is obligated to make a fully informed recommendation in order to meaningfully assist decisionmakers in determining whether or not it is appropriate, i.e.,

[67] *See* 10 C.F.R. § 51.95(c)(4).
[68] *See* 10 C.F.R. Part 51, Table B-1 of Appendix B to Subpart A; GEIS § 3.9.
[69] *See* 10 C.F.R. § 51.95(c)(4).
[70] 50 C.F.R. § 402.14(g)(4).

environmentally acceptable, to relicense Indian Point.[71] Riverkeeper's contention, thus, also raises an issue that is "material to the findings the NRC must make" since it challenges the adequacy of NRC Staff's recommendation on license renewal in light of NRC Staff's failure to discuss and explain its recommendation in light of the newly assessed information and circumstances. This is a "finding" that NRC Staff must make to support its FSEIS and NEPA review process concerning the proposed license renewal of Indian Point.

V. Statement of Facts Which Support Amended Contention RK-EC-8A Pursuant to 10 C.F.R. § 2.309(f)(1)(v)

Riverkeeper's Amended Contention EC-8A is supported by facts and evidence demonstrating that (1) the continued operation of Indian Point will unequivocally impact endangered species in the Hudson River, (2) in the context of required ESA § 7 consultation, NMFS has conducted an analysis and reached conclusions that are flawed in numerous respects, and improperly minimize the significant impact that may occur on endangered resources as a result of relicensing Indian Point for an additional 20 years, (3) NRC Staff has failed to discuss such deficiencies *at all* in the context of NRC Staff's supplemental NEPA review process, the absence of which renders NRC Staff's findings and conclusions regarding endangered species and, in turn, the appropriateness of relicensing Indian Point, factually and legally deficient, and (4) NRC Staff has failed to explain how its new assessments and conclusions affect its required recommendation regarding the appropriateness of relicensing Indian Point.

VI. Amended Contention RK-EC-8A Presents a Genuine Dispute Pursuant to 10 C.F.R. § 2.309(f)(1)(vi)

There is "sufficient information to show that a genuine dispute exists" regarding a material issue of law or fact, in accordance with 10 C.F.R. § 2.309(f)(1)(vi). First, NRC Staff's final FSEIS supplement completely disregards all of Riverkeeper's valid and expert (and NYS)

[71] *See* 10 C.F.R. § 51.95(c)(4).

supported concerns regarding deficiencies in NMFS' Final BiOp pertaining to the proposed license renewal of Indian Point. Thus, it is plain that NRC Staff is satisfied with its final conclusions in relation to impacts to endangered species in the FSEIS. The sufficiency of NRC Staff's assessment and conclusions related to endangered species impacts is patently an issue that Riverkeeper disputes with NRC Staff. Based on NRC Staff's apparent position and the information presented herein, there are various genuine disputes of material issues of law and/or fact, including whether NRC Staff's final FSEIS supplement has provided sufficient analysis of the impacts of Indian Point on endangered aquatic species in light of the numerous deficiencies of NMFS' conclusions and recommendations in its Final BiOp related to the proposed license renewal of Indian Point, as raised in NEPA comments by Riverkeeper, as well as by NYSDEC.

In addition, a genuine dispute exists in relation to NRC Staff's compliance with 10 C.F.R. § 51.95(c)(4), that is, the adequacy of NRC Staff's recommendation on license renewal in light of NRC Staff's failure to explain how its assessment of new information and circumstances affects NRC Staff's required recommendation.

VII. Amended Contention RK-EC-8A is Timely Pursuant to 10 C.F.R. § 2.309(f)(2)

Riverkeeper's Amended Contention EC-8A is a contention based on the assessment and conclusions contained in NRC Staff's final FSEIS supplement, and is timely pursuant to ASLB's Order of July 9, 2013.[72] Riverkeeper must, therefore, only satisfy the requirements of 10 C.F.R. § 2.309(f)(2), which the following amply demonstrates:

A. *Amended Contention RK-EC-8A is Based on Information Not Previously Available*

Riverkeeper's Amended Contention EC-8A is based on the assessment and conclusions in NRC Staff's final FSEIS supplement related to endangered species impacts, which do not

[72] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (Establishing Deadline for Motions for New and Amended Contentions) (July 9, 2013), ADAMS Accession No. ML13190A063.

adequately take into account the various deficiencies in NMFS' Final BiOp concerning the proposed license renewal of Indian Point, which were raised by Riverkeeper in comments pursuant to NEPA. NRC Staff's "disposition" of Riverkeeper's NEPA comments, as well as NYSDEC's concerns, related to NMFS' deficient assessment of endangered species impacts was not known, and, thus, was not "available," until the final FSEIS supplement was issued. Only once NRC Staff issued its final FSEIS supplement did it become known that NRC Staff ignored critical concerns raised by Riverkeeper and NYS, and, as a result, put forth unsubstantiated conclusions regarding endangered species impacts resulting from the proposed license renewal of Indian Point.

In addition, Riverkeeper's contention is based on NRC Staff's failure to indicate how its assessment of new information and circumstances in the FSEIS supplement affects its overall recommendation on the proposed license renewal of Indian Point pursuant to 10 C.F.R. § 51.95. NRC Staff's omission of a critical discussion of its recommendation on license renewal was not known, and, thus, was not "available," until the final FSEIS supplement was issued. That is, once again, only after NRC Staff issued its final FSEIS supplement did it become apparent that NRC Staff failed to revise and update its recommendation on the appropriateness of relicensing Indian Point.

B. <u>Amended Contention RK-EC-8A is Based on Information that is Materially Different than Previously Available Information</u>

Riverkeeper's Amended Contention RK-EC-8A is based on materially different information than was previously available. In particular, the amended contention is based upon the outcome of the ESA § 7 consultation process and NMFS' deficient Final BiOp resulting therefrom, as well as NRC Staff's treatment of Riverkeeper's NEPA comments relating to such deficiencies. Such information was not available at the time of Riverkeeper's initial contention

RK-EC-8, since it was proffered when ESA § 7 consultation had yet to even substantively commence. As the contention was held in abeyance pending guidance from the ASLB after the NRC Staff concluded its supplemental NEPA process,[73] and it was unclear how NRC Staff would respond to Riverkeeper's concerns related to NMFS' Final BiOp,[74] this is the earliest time, and unequivocally the appropriate time, for Riverkeeper to raise the instant amended contention related to this materially different information.

Moreover, the established NEPA regulatory structure of ESA § 7 consultation and applicable guidance contemplate that public comments are meaningfully considered and addressed during the NEPA review.[75] NRC Staff's materially different approach in issuing its final FSEIS supplement without any consideration of Riverkeeper's concerns about NRC Staff's reliance on NMFS' deficient analysis and conclusions was not known until the issuance of the final FSEIS supplement. At that point, it became clear that NRC Staff intended to proceed in a manner that was materially different from what is required. There was no way of knowing

---

[73] *See* In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (December 14, 2011), at 2, ADAMS Accession No. ML11348A032.

[74] Thus, it would have been inappropriate and premature for Riverkeeper to raise a new or amended contention earlier in the proceeding, such as at the time NMFS issued its Final BiOp. Notably, Riverkeeper articulated its concerns related to NMFS' assessment at every appropriate juncture. *See supra* at Background; *see also* Attachment 2, Attachment 5.

[75] *Vermont Yankee Nuclear Power Corp. V. Natural Resources Defense Council*, 435 U.S. 519, 558 (1978); *see also Entergy Nuclear Generation Co. and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station), LBP-06-23, 64 NRC 257, 277 (2006), quoting *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989) (NEPA seeks to ensure "a fully informed and well-considered decision."); *Marsh*, 490 U.S. at 374 (An environmental impact statement prepared pursuant to NEPA must be searching and rigorous, providing a "hard look" at the environmental consequences of the agency's proposed action); 40 C.F.R. § 1502.9(a), (b) ("The lead agency shall work with the cooperating agencies and shall obtain comments . . . . Final environmental impact statements shall respond to comments as required"); 40 C.F.R. § 1503.4(a) ("An agency preparing a final environmental impact statement shall assess and consider comments both individually and collectively, and shall respond . . ."); 40 C.F.R. § 1503.4(b) (The reviewing agency must attach "[a]ll substantive comments received on the draft statement (or summaries thereof . . .) . . . whether or not the comment is thought to merit individual discussion by the agency."); *see also* Notice of Availability, Draft Supplement To Supplement 38 To The Generic Environmental Impact Statement For License Renewal Of Nuclear Plants, 77 Fed. Reg. 40,091, 40,091-92 (July 6, 2013), *available at*, https://www.federalregister.gov/articles/2012/07/06/2012-16548/entergy-nuclear-operations-inc-indian-point-nuclear-generating-units-2-and-3 ("Submit comments by August 20, 2012. Comments received after this date will be considered if it is practical to do so.").

whether or to what degree NRC Staff would address Riverkeeper's valid concerns until the final FSEIS supplement was issued.

Further, the amended contention is also based on NRC Staff's failure to indicate how its assessment of new information and circumstances in the FSEIS supplement affects its overall recommendation on the proposed license renewal of Indian Point pursuant to 10 C.F.R. § 51.95. Similarly, it was not known that NRC Staff would proceed in this materially different manner, i.e., contrary to applicable regulations, until NRC Staff completed its supplemental NEPA review process and issued the FSEIS supplement.

C. *Amended Contention RK-EC-8A has been Submitted in Timely Fashion Based on Availability of the New Information*

The ASLB has ordered that "new or amended contentions arising from the recently published FSEIS Supplement will be considered timely if filed on or before August 20, 2013."[76] Thus, Amended Contention EC-8A, filed August 20, 2013, has been submitted in a timely fashion.

CONCLUSION

For the foregoing reasons, the ASLB should admit Riverkeeper's Amended Contention RK-EC-8A for adjudication in the Indian Point license renewal proceeding.

Respectfully submitted,

Signed (electronically) by Deborah Brancato
Deborah Brancato, Esq.
Phillip Musegaas, Esq.
Riverkeeper, Inc
20 Secor Road
Ossining, NY 10562
914-478-4501 (ext. 230)
dbrancato@riverkeeper.org
phillip@riverkeeper.org

[76] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (Establishing Deadline for Motions for New and Amended Contentions) (July 9, 2013), ADAMS Accession No. ML13190A063.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos.
	)	50-247-LR
Entergy Nuclear Operations, Inc.	)	and 50-286-LR
(Indian Point Nuclear Generating	)	
Units 2 and 3)	)	August 20, 2013

Certification Pursuant to 10 C.F.R. § 2.323(b)

Pursuant to 10 C.F.R. § 2.323(b) and the ASLB's July 1, 2010 Scheduling Order ¶ G.6, I certify that I have made a sincere effort to contact the other parties in this proceeding, to explain to them the factual and legal issues raised in this motion, and to resolve those issues, and I certify that my efforts have been unsuccessful. While counsel for NRC Staff and Entergy indicated that they would not oppose Riverkeeper's motion for leave to file the amended contention, both parties took no position on the contention, and reserved their rights to respond once the contention was filed. Counsel for New York State has indicated that New York State does not oppose Riverkeeper's amended contention.

Signed (electronically) by Deborah Brancato
Deborah Brancato, Esq.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

	)	
In the Matter of	)	Docket Nos.
	)	50-247-LR
Entergy Nuclear Operations, Inc.	)	and 50-286-LR
(Indian Point Nuclear Generating	)	
Units 2 and 3)	)	August 20, 2013
	)	

CERTIFICATE OF SERVICE

I certify that on August 20, 2013 copies of Riverkeeper, Inc. Consolidated Motion for Leave to File Amended Contention RK-EC-8A and Amended Contention RK-EC-8A, were served on the following by NRC's Electronic Information Exchange:

Lawrence G. McDade, Chair Atomic Safety and Licensing Board Panel Atomic Safety and Licensing Board U.S. Nuclear Regulatory Commission Washington, D.C. 20555 E-mail: Lawrence.McDade@nrc.gov	Michael F. Kennedy Atomic Safety and Licensing Board Panel Atomic Safety and Licensing Board U.S. Nuclear Regulatory Commission Washington, D.C. 20555 E-mail: Michael.Kennedy@nrc.gov
Richard E. Wardwell Atomic Safety and Licensing Board U.S. Nuclear Regulatory Commission Washington, D.C. 20555 E-mail: Richard.Wardwell@nrc.gov	Office of Commission Appellate Adjudication U.S. Nuclear Regulatory Commission Washington, D.C. 20555 E-mail: OCAAMAIL@nrc.gov
Office of the Secretary Rulemakings and Adjudications Staff U.S. Nuclear Regulatory Commission Washington, D.C. 20555 E-mail: HEARINGDOCKET@nrc.gov	Elise N. Zoli, Esq. Goodwin Procter, LLP 53 State Street Boston, MA 02109 E-mail: ezoli@goodwinprocter.com
William C. Dennis, Esq. William B. Glew, Jr. Entergy Nuclear Operations, Inc. 440 Hamilton Avenue White Plains, NY 10601 E-mail: wdennis@entergy.com wglew@entergy.com	Melissa-Jean Rotini Assistant County Attorney Office of Robert F. Meehan, Westchester County Attorney 148 Martine Avenue, 6th Floor White Plains, NY 10601 E-mail: MJR1@westchestergov.com

Shelbie Lewman, Law Clerk James Maltese, Law Clerk Carter Thurman, Law Clerk Atomic Safety and Licensing Board Panel U.S. Nuclear Regulatory Commission Washington, D.C. 20555 shelbie.lewman@nrc.gov james.maltese@nrc.gov carter.thurman@nrc.gov	Clint Carpenter, Esq. Bobby Burchfield, Esq. Matthew Leland, Esq. McDermott, Will and Emery LLP 600 13th Street, NW Washington, DC 20005 ccarpenter@mwe.com bburchfield@mwe.com mleland@mwe.com
John J. Sipos Charles Donaldson Assistant Attorneys General Office of the New York Attorney General for the State of New York The Capitol Albany, NY 12224 E-mail: John.Sipos@oag.state.ny.us charlie.donaldson@ag.ny.gov	Edward F. McTiernan, Esq. New York State Department of Environmental Conservation Office of General Counsel 625 Broadway 14th Floor Albany, NY 12233-1500 efmctier@gw.dec.state.ny.us
Matthew W. Swinehart, Esq. Covington & Burling LLP 1201 Pennsylvania Avenue, NW Washington, DC 20004 mswinehart@cov.com	Martin J. O'Neill, Esq. Morgan, Lewis & Bockius, LLP 1000 Louisiana Street, Suite 4000 Houston, TX 77002 E-mail: martin.oneill@morganlewis.com
Manna Jo Greene Stephen C. Filler Hudson River Sloop Clearwater, Inc. 724 Wolcott Ave Beacon, New York 12508 E-mail: Mannajo@clearwater.org stephenfiller@gmail.com	Janice A. Dean Kathryn Liberatore Assistant Attorney General Office of the Attorney General 120 Broadway, 26th Floor New York, NY 10271 E-mail: Janice.dean@oag.state.ny.us kathryn.liberatore@ag.ny.gov
Michael J. Delaney Department of Environmental Protection 59-17 Junction Boulevard Flushing NY 11373 E-mail: mdelaney@dep.nyc.gov	OGC Mail Center OGCMailCenter@nrc.gov

Richard Webster, Esq. Public Justice, P.C. For Hudson River Sloop Clearwater, Inc. 1825 K Street, NW, Suite 200 Washington, D.C. 20006 rwebster@publicjustice.net	Robert D. Snook, Esq. Assistant Attorney General 55 Elm Street, P.O. Box 120 Hartford, CT 06141-0120 E-mail: Robert.Snook@po.state.ct.us
Thomas F. Wood, Esq. Daniel Riesel, Esq. Victoria S. Treanor Adam Stolorow Jwala Gandhi Peng Deng Sive, Paget and Riesel, P.C. 460 Park Avenue New York, NY 10022 E-mail: driesel@sprlaw.com vtreanor@sprlaw.com astolorow@sprlaw.com jgandhi@sprlaw.com pdeng@sprlaw.com	Sean Murray, Mayor Kevin Hay, Village Administrator Village of Buchanan Municipal Building 236 Tate Avenue Buchanan, NY 10511-1298 E-mail: vob@bestweb.net, SMurray@villageofbuchanan.com, Administrator@villageofbuchanan.com
Kathryn M. Sutton, Esq. Paul M. Bessette, Esq. Jonathan M. Rund, Esq. Raphael Kuyler Lena Michelle Long Laura Swett Lance Escher Mary Freeze Antoinette Walker Doris Calhoun Morgan, Lewis & Bockius, LLP 1111 Pennsylvania Ave. N.W. Washington, D.C. 20004 E-mail: ksutton@morganlewis.com pbessette@morganlewis.com jrund@morganlewis.com rkuyler@morganlewis.com llong@morganlewis.com lswett@morganlewis.com lescher@morganlewis.com mfreeze@morganlewis.com awalker@morganlewis.com dcalhoun@morganlewis.com	Sherwin E. Turk Beth N. Mizuno Brian G. Harris David E. Roth Edward L. Williamson Mary B. Spencer Anita Ghosh John Tibbetts Office of General Counsel Mail Stop: 0-15D21 U.S. Nuclear Regulatory Commission Washington, D.C. 20555-0001 E-mail: Sherwin.Turk@nrc.gov Beth.Mizuno@nrc.gov brian.harris@nrc.gov David.Roth@nrc.gov edward.williamson@nrc.gov mary.spencer@nrc.gov anita.ghosh@nrc.gov john.tibbetts@nrc.gov

Signed (electronically) by Deborah Brancato
Deborah Brancato

August 20, 2013

Riverkeeper Amended Contention RK-EC-8A:

Attachment 1

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

AUG 2 6 2011

David J. Wrona, Branch Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Program
US Nuclear Regulatory Commission
Washington, DC 20555-0001

RE: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3

Dear Mr. Wrona:

Please find enclosed a copy of the draft Biological Opinion on the effects of the operation of the Indian Point Nuclear Generating Station Units 2 and 3 (Indian Point) pursuant to a renewed operating license that the Nuclear Regulatory Commission (Commission) proposes to issue to Entergy Nuclear Operations, Inc. (Entergy). I understand that Entergy requested a copy of a draft Opinion from you. In light of the schedule for consultation, please provide your comments and a copy of Entergy's comments to me by September 6, 2011.

While I am providing you a copy of the draft Opinion now in light of the consultation schedule, I would also welcome your comments on whether initiation of consultation on this matter was appropriate at this particular time. When initiating consultation with NOAA's National Marine Fisheries Service (NMFS), the Commission staff defined the proposed action as the operation of Indian Point for the new 20-year license term under the same conditions that appear in the existing license and the existing State Pollution Discharge Elimination System (SPDES) permit. However, as most recently discussed in a letter to me from the New York State Department of Environmental Conservation (NYSDEC), the proposed action seems very uncertain given NYSDEC has denied Entergy's request for Clean Water Act Section 401 Water Quality Certification based on its initial and amended application. I understand that the denial and the draft SPDES permit are under adjudication. The potential modification of the proposed action due to the anticipated modification of the SPDES permit, including application of different technologies to the cooling water system, as well as monitoring requirements tailored to them, renders the utility of issuing a final Opinion at this time highly questionable. This Opinion only analyzes the operation of Indian Point from approximately 2013 to 2035 under the same conditions that appear in the existing license and SPDES permit, and the analysis and conclusions cannot be interpreted to apply to a different time period or different set of operating conditions. It would not be appropriate to use the Opinion as an indication of a "worst-case scenario," given the Opinion's analysis and determinations may need to be modified as the definition of the proposed action and its effects, the environmental baseline, and the status of species protected under the Endangered Species Act (ESA) all may change.

Given that you have initiated Section 7 consultation, it appears you have already determined that the Commission has discretionary involvement or control over the action that inures to the benefit of ESA-listed species under NMFS jurisdiction. However, the Biological Assessment and the Final Supplemental Environmental Impact Statement seem to suggest that the Commission cannot condition the operating license for the benefit of aquatic life in a way that affects the cooling water system. Those documents point to Congress's delegation to the United States Environmental Protection Agency (EPA) of authority to administer the Clean Water Act's procedural and substantive provisions, and EPA's subsequent delegation of SPDES authority to the State of New York, as the basis for the Commission "deferring" to the NYSDEC regarding the protection of aquatic life. While I take no position on whether that is appropriate for implementation of the Clean Water Act, I note that the Endangered Species Act is a separate statute from the Clean Water Act and has different goals, standards, requirements and prohibitions applicable to all Federal agencies. In light of this, I welcome your comments explaining the Commission's legal authority to approve and enforce conditions in the renewed operating license to minimize, monitor, and report incidental take resulting from the operation of the facility in order to fulfill its Endangered Species Act obligations. In addition, I request confirmation from the Commission of the legal basis by which it retains discretionary involvement or control over the action in order to reinitiate consultation if an Opinion is finalized and any of the criteria for reinitiation are met at a later date (see 50 C.F.R. Sec. 402.16).

To aid your consideration of these questions, the draft Opinion contains an Incidental Take Statement with preliminary Reasonable and Prudent Measures and Terms and Conditions to minimize, monitor, and report on the amount or extent of incidental take due to the operation of the facility under the proposed license renewal and existing SPDES permit. Given the overlapping Federal and state jurisdiction over endangered species in the Hudson River, NMFS is interested in working closely with our sister agencies at the state level and with other Federal partners to ensure the outcomes of the various processes are compatible and arrived at in an efficient manner. For this reason, too, I ask you to consider the appropriateness of having initiated consultation at this time. The Section 7 regulations at 50 C.F.R. Sec. 402.14(l)(2) state that "if during any stage of consultation a Federal agency determines its proposed action is not likely to occur, the consultation may be terminated by written notice to the Service." At an appropriate time, such as when the terms of the proposed extended operation of Indian Point are more certain, consultation may be initiated anew.

I appreciate your interest in the conservation of endangered species and look forward to your response as well as continuing to work with you on this matter.

Sincerely,

for Patricia A. Kurkul
Regional Administrator

CC: Crocker, F/NER3
Williams, GCNE

File Code: Sec 7 NRC – Indian Point Relicensing
F/NER/2009/00619

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION

DRAFT

BIOLOGICAL OPINION

Agency:	Nuclear Regulatory Commission
Activity:	**Relicensing – Indian Point Nuclear Generating Station F/NER/2009/00619**
Conducted by:	NOAA's National Marine Fisheries Service Northeast Regional Office
Date Issued:	DRAFT
Approved by:	DRAFT

INTRODUCTION

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) issued in accordance with section 7 of the Endangered Species Act of 1973, as amended, on the effects of the continued operation of the Indian Point Nuclear Generating Station (Indian Point) pursuant to a renewed operating license proposed to be issued by the Nuclear Regulatory Commission (NRC) in accordance with the Atomic Energy Act of 1954 as amended (68 Stat. 919) and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242).

This Opinion is based on information provided in a Biological Assessment dated December 2010, the Final *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38 Regarding Indian Point Nuclear Generating Unit 2 and 3* dated December 2010, permits issued by the State of New York, information submitted to NMFS by Entergy and other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Northeast Regional Office, Gloucester, Massachusetts.

BACKGROUND AND CONSULTATION HISTORY

Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) are located on approximately 239 acres (97 hectares (ha)) of land in the Village of Buchanan in upper Westchester County, New York (project location is illustrated in Figures 1 and 2). The facility is on the eastern bank of the Hudson River at river mile (RM) 43 (river kilometer (RKM) 69) about 2.5 miles (mi) (4.0 kilometers (km)) southwest of Peekskill, the closest city, and about 24 mi (39 km) north of New York City. Both IP2 and IP3 use Westinghouse pressurized-water reactors and nuclear steam supply systems (NSSSs). Primary and secondary plant cooling is provided by a once-through cooling water intake system that supplies cooling water from the Hudson River. Indian Point Nuclear Generating Station Unit No. 1 (IP1, now permanently shut down) shares the site with IP2 and IP3. IP1 is located between IP2 and IP3. In 1963, IP1 began operations. IP1 was shut down on October 31, 1974, and is in a safe storage condition (SAFSTOR) awaiting final decommissioning. Construction began on IP2 in 1966 and on IP3 in 1969.

Indian Point Unit 2 was initially licensed by the Atomic Energy Commission (AEC), the predecessor to the NRC, on September 28, 1973. The AEC issued a 40-year license for Unit 2 that will expire on September 29, 2013. Unit 2 was originally licensed to the Consolidated Edison Company, which sold that facility to Entergy in September 2001. Indian Point Unit 3 was initially licensed on December 12, 1976, for a 40-year period that will expire in December 2015. While the Consolidated Edison Company of New York originally owned and operated Unit 3, it was later conveyed to the Power Authority of the State of New York (PASNY – the predecessor to the New York Power Authority [NYPA]). PASNY/NYPA operated Unit 3 until November 2000 when it was sold to Entergy.

Endangered Species Act Consultation
The Endangered Species Act was enacted in 1973. However, there was no requirement in the 1973 Act for the Secretary to produce a written statement setting forth his biological opinion on the effects of the action and whether the action will jeopardize the continued existence of listed species and/or destroy or adversely modify critical habitat. It was not until Congress amended the Act in 1978 that the Secretary was required to produce a Biological Opinion. The 1973 Act, including as amended in 1978, prohibited the "take" of endangered species. In 1982, Congress amended the Act to provide for an "Incidental Take Statement" in a Biological Opinion that specifies the level of incidental "take," identifies measures to minimize the level of incidental "take," and exempts any incidental "take" that occurs in compliance with those measures. To date, NMFS has not exempted any incidental take at IP2 and IP3 from the Section 9 prohibitions against take.

As explained below, beginning in 1977, EPA held a series of hearings (Adjudicatory Hearing Docket No. C/II-WP-77-01) regarding the once through cooling systems at Indian Point, Roseton, Danskammer and Bowline Point, all power facilities located along the Hudson River. During the course of these hearings, Dr. Mike Dadswell testified on the effects of the Indian Point facility on shortnose sturgeon. In a filing dated May 14, 1979, NOAA submitted this testimony to the US EPA as constituting NMFS "Biological Opinion on the impacts of the utilities' once through cooling system on the shortnose sturgeon." The filing notes that this opinion is required by section 7 of the ESA of 1973, as amended.

In this testimony, Dr. Dadswell provides information on the life history of shortnose sturgeon and summarizes what was known at the time about the population in the Hudson River. Dr. Dadswell indicates that at the time it was estimated that there were approximately 6,000 adult and sub-adult shortnose sturgeon in the Hudson River population (Dadswell 1979) and that the population had been stable at this number between the 1930s and 1970s. Dr. Dadswell determined that there is no known entrainment of shortnose sturgeon at these facilities and little, if any, could be anticipated. Based on available information regarding impingement at IP2 and IP3, Dadswell estimated a worst case scenario of 35 shortnose sturgeon impingements per year, including 21 mortalities (assuming a 60% impingement mortality). Dadswell estimated that this resulted in a loss of 0.3-0.4% of the shortnose sturgeon population in the Hudson each year and that this additional source of mortality will not "appreciably reduce the likelihood of the survival and recovery of the shortnose sturgeon." In conclusion Dadswell stated that the once through cooling systems being considered in the case were "not likely to jeopardize the continued existence of the shortnose sturgeon because, even assuming 100% mortality of impinged fish, its contribution to the natural annual mortality is negligible." Dr. Dadswell did also note that as there is no positive benefit to impingement, any reductions in the level of impingement would aid in the conservation of the species. No additional ESA consultation has occurred between NRC and NMFS on the operation of IP2 and IP3 and the effects on shortnose sturgeon; incidental take associated with IP2 or IP3 has never been exempted.

In advance of the current relicensing proceedings, NRC began coordination with NMFS in 2007. In a letter dated August 16, 2007 NRC requested information from NMFS on Federally listed endangered or threatened species, as well as on proposed or candidate species, and on any designated critical habitats that may occur in the vicinity of IP2 and IP3. In its response, dated October 4, 2007,, NMFS expressed concern that the continued operation of IP2 and IP3 could have an impact on the shortnose sturgeon *(Acipenser brevirostrum)*. In a letter dated December 22, 2008, NRC requested formal consultation with NMFS to consider effects of the proposed relicensing on shortnose sturgeon. With this letter NRC transmitted a Biological Assessment (BA). In a letter dated February 24, 2009 NMFS requested additional information on effects of the proposed relicensing on shortnose sturgeon. In a letter dated December 10, 2010, NRC provided the information that was available and transmitted a revised BA. In the original BA, NRC staff relied on data originally supplied by the applicant, Entergy Nuclear Operations, Inc. (Entergy). NRC sought and Entergy later submitted revised impingement data, which was incorporated into the final BA. Mathematical errors in the original data submitted to the NRC resulted in overestimates of the impingement of shortnose sturgeon that the NRC staff presented in the previous BA.

On June 16, 2011 NMFS received information regarding Entergy's triaxial thermal plume study and staff obtained a copy of the study and supporting documentation from NYDEC's webpage on that date. Additional information regarding the intakes was provided by Entergy via conference call on June 20, June 22, and June 29, 2011. Supplemental information responding to specific questions raised by NMFS regarding the thermal plume was submitted by Entergy via e-mail on July 8, July 25, and August 5, 2011. NRC provided NMFS with a supplement to the December 2010 BA considering the new thermal plume information, on July 27, 2011.

DESCRIPTION OF THE PROPOSED ACTION

The proposed Federal action is the operation of Indian Point Units 2 and 3 pursuant to NRC's proposed renewed power reactor operating licenses to Entergy for IP2 and IP3. The current 40-year licenses expire in 2013 (IP2) and 2015 (IP3). Without renewal, the facilities would close at the end of the current operating period. The proposed action would authorize the extended operation of IP2 from September 2013 through September 2033 and IP3 from December 2015 through December 2035. In this Opinion, NMFS considers the potential impacts of the continued operation of the facility during the extended operation period.

Details on the operation of the facilities over the extended operating period, as proposed by Entergy in the license application and as described by NRC in the FEIS and BA, are described below. Both units withdraw water from and discharge water to, the Hudson River. As described by NRC in the Final SEIS (NRC 2010), in 1972, Congress assigned authority to administer the Clean Water Act to the US Environmental Protection Agency (EPA). The CWA further allowed EPA to delegate portions of its CWA authority to states. On October 28, 1975, EPA authorized the State of New York to issue National Pollutant Discharge Elimination System (NPDES) permits. New York's NPDES, or State Pollutant Discharge Elimination System (SPDES), program is administered by the NY Department of Environmental Conservation (NYDEC). NYDEC issues and enforces SPDES permits for IP2 and IP3.

Section 316(b) of the Clean Water Act of 1977 (CWA) requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). EPA regulates impingement and entrainment under Section 316(b) of the CWA through the NPDES permit process. Administration of Section 316(b) has also been delegated to NYDEC, and that provision is implemented through the SPDES program.

Neither IP2 or IP3 can operate without cooling water, and NRC is responsible for authorizing the operation of nuclear facilities, as well as approving any extension of an initial operating license through the license renewal process. Intake and discharge of water through the cooling water system would not occur but for the operation of the facility pursuant to a renewed license; therefore, the effects of the cooling water system on shortnose sturgeon are a direct effect of the proposed action. NRC staff state that the authority to regulate cooling water intakes and discharges under the Clean Water Act lies with EPA, or in this case, NYDEC, as the state has been delegated NPDES authority by EPA. Pursuant to NRC's regulations, operating licenses are conditioned upon compliance with all applicable law, including but not limited to Clean Water Act Section 401 Certifications and NPDES/SPDES permits. Therefore, the effects of the proposed Federal action-- the continued operation of IP2 and IP3 as proposed to be approved by NRC, which necessarily involves the removal and discharge of water from the Hudson River-- are shaped not only by the terms of the renewed operating license but also by the NYDEC 401 Water Quality Certification and any conditions it may contain that would be incorporated into its SPDES permits. This Opinion will consider the effects of the operation of IP2 and IP3 pursuant to the extended Operating License to be issued by the NRC and the SPDES permits issued by NYDEC that are already in effect. NRC requested consultation on the operation of the facilities under the existing NRC license terms and the existing SPDES permits, even though a new SPDES permit might be issued in the future. A complete history of NYDEC permits is included in NRC's FSEIS at Section 2.2.53 (Regulatory Framework and Monitoring Programs) and is summarized below.

NPDES/SPDES Permits

Section 316(b) of the Clean Water Act of 1977 (CWA) requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). In July 2004, the U.S. Environmental Protection Agency (EPA) published the Phase II Rule implementing Section 316(b) of the CWA for Existing Facilities (69 FR 41576), which applied to large power producers that withdraw large amounts of surface water for cooling (50 MGD or more) (189,000 m3/day or more). The rule became effective on September 7, 2004 and included numeric performance standards for reductions in impingement mortality and entrainment that would demonstrate that the cooling water intake system constitutes BTA for minimizing impingement and entrainment impacts. Existing facilities subject to the rule were required to demonstrate compliance with the rule's performance standards during the renewal process for their National Pollutant Discharge Elimination System (NPDES) permit through development of a Comprehensive Demonstration Study (CDS). As a result of a Federal court decision, EPA officially suspended the Phase II rule on July 9, 2007 (72 FR 37107) pending further rulemaking. EPA instructed permitting authorities to utilize best professional judgment in establishing permit requirements on a case by-case basis for cooling water intake structures at Phase II facilities until it has resolved the issues raised by the court's ruling.

The licenses issued by the AEC for Units 2 and 3 initially allowed for the operation of those facilities with once-through cooling systems. However, the licenses required the future installation of closed-cycle cooling systems at both facilities, by certain dates, because of the potential for long term environmental impact from the once-through cooling systems on aquatic life in the Hudson River, particularly striped bass. A closed cycle cooling system is expected to withdraw approximately 90-95% less water than a once through cooling system. The license for Unit 2 was amended by the NRC in 1975, and the license for Unit 3 was amended by the NRC in 1976, to include requirements for the installation and operation of wet closed-cycle cooling systems at the facilities.

NRC eventually concluded that the operating licenses for the facilities should be amended to authorize construction of natural draft cooling towers at each Unit. Prior to the respective deadlines for installation of closed-cycle cooling at the Indian Point facilities, however, the NRC's authority to require the retrofit due to water quality impacts under federal nuclear licenses was superseded by comprehensive amendments to the federal Water Pollution Prevention and Control Act (the Clean Water Act [CWA]) and creation of the National Pollutant Discharge Elimination System (NPDES) program.

In 1975, the U.S. Environmental Protection Agency (EPA) issued separate NPDES permits for Units 2 and 3, pursuant to provisions of the CWA, chiefly § 316 (33 U.S.C. § 1326), that required both facilities to discontinue discharging heated effluent from the main condensers. The NPDES permits provided that "heat may be discharged in blowdown from a re-circulated cooling water system." The intent of these conditions was to require the facilities to install closed-cycle cooling systems in order to reduce the thermal and other adverse environmental impacts from the operation of Indian Point's CWISs upon aquatic organisms in the Hudson River. In 1977, the facilities' owners, Consolidated Edison Company of New York and PASNY/NYPA, requested administrative hearings with the USEPA to overturn these conditions.

In October 1975, NYDEC received approval from the USEPA to administer and conduct a State permit program pursuant to the provisions of the federal NPDES program under CWA § 402. Since then, the Department has administered that program under the State Pollutant Discharge Elimination System (SPDES) permit program. As a result, NYDEC has the authority, under the CWA and state law, to issue SPDES permits for the withdrawal of cooling water for operations at the Indian Point facilities and for the resulting discharge of waste heat and other pollutants into the Hudson River. The terms of the SPDES permit, however, become part of the Federal action given that the operating license shall be subject to the conditions imposed under the Clean Water Act.

As previously noted, in 1977 the then-owners of the Indian Point nuclear facilities sought an adjudicatory proceeding to overturn the USEPA-issued NPDES permit determinations that limited the scope of the facilities' cooling water intake operations. The USEPA's adjudicatory process lasted for several years before culminating in a multi-party settlement known as the Hudson River Settlement Agreement[1] (HRSA). The HRSA was initially a ten-year agreement whereby the owners of certain once-through cooled electric generating plants on the Hudson River, including Indian Point, would collect biological data and complete analytical assessments to determine the scope of adverse environmental impact caused by those facilities. According to the NYDEC, the intent of the HRSA was that, based upon the data and analyses provided by the facilities, the Department could determine, and parties could agree upon, the best technology available (BTA) to minimize adverse environmental impact on aquatic organisms in the Hudson River from these facilities in accordance with 6 NYCRR § 704.5. The Settlement obligated the utilities to undertake a series of operational steps to reduce fish kills, including partial outages during the key spawning months. In addition, the utilities agreed to fund and operate a striped bass hatchery, conduct biological monitoring, and set up a $12 million endowment for a new foundation for independent research on mitigating fish impacts by power plants. The agreement became effective upon Public Service Commission approval on May 8, 1981. The terms of the 1980 HRSA were extended through a series of four separate stipulations of settlement and judicial consent orders that were entered in Albany County Supreme Court [Index No. 0191-ST3251]. The last of these stipulations of settlement and judicial consent orders, executed by the parties in 1997, expired on February 1, 1998.

In 1982, NYDEC issued a SPDES permit for Indian Point Units 2 and 3, and other Hudson River electric generating facilities, as well as a § 401 WQC for the facilities. The 1982 SPDES permit for Units 2 and 3 contained special conditions for reducing some of the environmental impact from the facilities' cooling water intakes but, based upon provisions of the HRSA, the permit did not require the installation of any technology for minimizing the number of organisms entrained by the facilities each year. Similarly, based upon provisions of the HRSA, the 1982 § 401 WQC did not make an independent determination that the facilities complied with certain applicable State water quality standards at that time, including 6 NYCRR Part 704 – Criteria Governing Thermal Discharges.

In accordance with the provisions of the HRSA, the Department renewed the SPDES permit for the Indian Point facilities in 1987 for another 5-year period. _As with the 1982 SPDES permit, the 1987 SPDES permit for Units 2 and 3 contained certain measures from the HRSA that were

1 The signatory parties to the HRSA were USEPA, the Department, the New York State Attorney General, the Hudson River Fishermen's Association, Scenic Hudson, the Natural Resources Defense Council, Central Hudson Gas & Electric Co., Consolidated Edison Co., Orange & Rockland Utilities, Niagara Mohawk Power Corp., and PASNY. Entergy was not a party to the HRSA because it did not own the Indian Point facilities at any time during the period covered by the HRSA.

intended to mitigate, but not minimize, the adverse environmental impact caused by the operation of the facilities' cooling water intakes. The 1987 SPDES permit expired on October 1, 1992. Prior to the expiration date, however, the owners of the facilities at that time, Consolidated Edison and NYPA, both submitted timely SPDES permit renewal applications to the Department and, by operation of the State Administrative Procedure Act (SAPA), the 1987 SPDES permit for Units 2 and 3 is still in effect today. Entergy purchased Units 2 and 3 in 2001 and 2000, respectively, and the 1987 SAPA-extended SPDES permit for the facilities was subsequently transferred to Entergy.

In November 2003, the Department issued a draft SPDES permit for Units 2 and 3 that required Entergy, among other things, to retrofit the Indian Point facilities with closed-cycle cooling or an equivalent technology in order to minimize the adverse environmental impact caused by the CWISs in accordance with 6 NYCRR § 704.5 and CWA § 316(b). The draft permit contains conditions which address three aspects of operations at Indian Point: conventional industrial wastewater pollutant discharges, thermal discharge, and cooling water intake. Limits on the conventional industrial discharges are not proposed to be changed significantly from the previous permit. The draft permit does, however, contain new conditions addressing the thermal discharge and additional new conditions to implement the measures NYDEC has determined to be the best technology available (BTA) for minimizing impacts to aquatic resources from the cooling water intake, including the installation of a closed cycle cooling system at IP2 and IP3. With respect to thermal discharges, the draft SPDES permit would require Entergy to conduct a tri-axial (three-dimensional) thermal study to document whether the thermal discharges from Units 2 and 3 comply with state water quality criteria. The draft permit states that if IP2 and IP3 do not meet state standards, Entergy may apply for a modification of those criteria in an effort to demonstrate to NYDEC that such criteria are unnecessarily restrictive and that the requested modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish and wildlife in the River, which is an applicable Clean Water Act water quality-related standard. The draft permit also states that Entergy may propose, within a year of the permit's becoming effective, an alternative technology or technologies that can minimize adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at the Stations. In order to implement closed-cycle cooling, the draft permit would require Entergy to submit a pre-design engineering report within one year of the permit's effective date. Within one year after the submission of the report, Entergy must submit complete design plans that address all construction issues for conversion to closed-cycle cooling. In addition, the draft permit requires Entergy to obtain approvals for the system's construction from other government agencies, including modification of the Stations' operating licenses from the NRC. While steps are being taken to implement BTA, Entergy would be required to schedule and take annual generation outages of no fewer than 42 unit-days during the peak entrainment season among other measures. In 2004, Entergy requested an adjudicatory hearing with NYDEC on the draft SPDES permit. That SPDES permit adjudicatory process is presently ongoing, and its outcome is uncertain at this time. There is significant uncertaintity associated with the conditions of any new SPDES permit. In the 2003 draft, NYDEC determined that cooling towers were the BTA to minimize adverse environmental effects. In a 2010 filing with NYDEC, Entergy proposed to use a system of cylindrical wedgewire screens, which Entergy states would reduce impingement and entrainment mortality to an extent comparable to the reductions in impingement and entrainment loss expected to result from operation with cooling towers. As no determination has been made regarding a revised draft SPDES permit or a final permit, it is unknown what new technology, if any, will be required to modify the operation of the facility's cooling water intakes. The 1987 SPDES permit is still in effect and will remain in effect until a new permit is issued and becomes effective. No schedule is available for the issuance of a revised draft or new final SPDES permit and the content of any SPDES permit will be decided as a result of the adjudication process. Therefore, in this consultation, NMFS has considered effects of the operation of the Indian Point facility over the 20-year extended operating period with the 1987 SPDES permit in effect. This scenario is also the one considered by NRC in the BA provided to NMFS in which NRC considered effects of the operation of the facility during the extended operating period on shortnose sturgeon. If a new SPDES permit is issued, NRC and NMFS would have to determine if reinitiation of this consultation is necessary to consider any effects of the operation of the facility on shortnose sturgeon that were not considered in this Opinion.

401 Water Quality Certificate

On April 6, 2009, NYDEC received a Joint Application for a federal Clean Water Act (CWA) § 401 Water Quality Certificate (WQC) on behalf of Entergy Indian Point Unit 2, LLC, Entergy Indian Point Unit 3, LLC, and Entergy Nuclear Northeast (collectively Entergy). The Joint Application for § 401 WQC was submitted to NYDEC as part of Entergy's federal license renewal. Pursuant to the CWA, a state must issue a certification verifying that an activity which results in a discharge into navigable waters, such as operation of the Indian Point facilities, meets state water quality standards before a federal license or permit for such activity can be issued. Entergy has requested NYDEC to issue a § 401 WQC to run concurrently with any renewed nuclear licenses for the Indian Point facilities.

In a decision dated April 2, 2010, NYDEC determined that the facilities, whether operated as they are currently or operated with the addition of a cylindrical wedge-wire screen system (NYDEC notes that this proposal was made by Entergy in a February 12, 2010, submission), "do not and will not comply with existing New York State water quality standards." Accordingly, pursuant to 6 NYCRR Part 621 (Uniform Procedures), NYDEC denied Entergy's request for a §401 WQC (NYDEC 2010). The reasons for denial, as stated by NYDEC were related to impingement and entrainment of aquatic organisms, the discharge of heated effluent, and failure to implement what NYDEC had determined to be the Best Technology Available (closed cycle cooling towers), to minimize adverse environmental impacts. Entergy has appealed the denial.The matter is currently under adjudication in the state administrative system, and the results are uncertain. If New York State ultimately issues a WQC, it may contain conditions that alter the operation of the facility and its cooling water system. If this occurs, NMFS and NRC would need to review the modifications to operations to determine if consultation would need to be reinitiated.

Description of Cooling Water System

IP2 and IP3 have once-through condenser cooling systems that withdraw water from and discharge water to the Hudson River. The maximum design flow rate for each cooling system is approximately 1,870 cubic feet per second (cfs), 840,000 gallons per minute (gpm), or 53.0 cubic meters per second (m3/s). Two shoreline intake structures, one for each unit, are located along the Hudson River on the northwestern edge of the site and provide cooling water to the site. Each structure consists of seven bays, six for circulating water and one for service water. The IP2 intake structure has seven independent bays, while the IP3 intake structure has seven bays that are served by a common plenum. In each structure, six of the seven bays contain cooling water pumps, and the seventh bay contains service/auxiliary water pumps. Before it is pumped to the condensers, river water passes through traveling screens in the intake structure bays to remove debris and fish.

The six IP2 circulating water intake pumps are dual-speed pumps. When operated at high speed (254 revolutions per minute (rpm)), each pump provides 312 cfs (140,000 gpm; 8.83 m3/s) and a dynamic head of 21 ft (6.4 m). At low speed (187 rpm), each pump provides 38 cfs (84,000 gpm; 5.30 m3/s) and a dynamic head of 15 ft (4.6 m). The six IP3 circulating water intake pumps are variable-speed pumps. When operated at high speed (360 rpm), each pump provides 312 cfs (140,000 gpm; 8.83 m3/s); at low speed, it provides a dynamic head of 29 ft (8.8 m) and 143 cfs (64,000 gpm; 4.05 m3/s).

In accordance with the October 1997 Consent Order (issued pursuant to the Hudson River Settlement Agreement), the applicant adjusts the speed of the intake pumps to mitigate impacts to the Hudson River. Each coolant pump bay is about 15 ft (4.6 m) wide at the entrance, and the bottom is located 27 ft (8.2 m) below mean sea level. Before entering the intake structure bays, water flows under a floating debris skimmer wall, or ice curtain, into the screen wells. This initial screen keeps floating debris and ice from entering the bay. At the entrance to each bay, water also passes through a subsurface bar screen (consisting of metal bars with 3 inch clear spacing) to prevent additional large debris from becoming entrained in the cooling system. At full speed, the approach velocity in front of the screens is 1 foot per second (fps); at reduced speed, the approach velocity is 0.6 fps (Entergy 2007a). As this area is behind a bulkhead it is outside the influence of river currents. Next, smaller debris and fish are screened out using modified Ristroph traveling screens.

The modified Ristroph traveling screens consist of a series of panels that rotate continuously. The traveling screens employed by IP2 and IP3 are modified vertical Ristroph-type traveling screens installed in 1990 and 1991 at IP3 and IP2, respectively. The screens were designed in concert with the Hudson River Fishermen's Association, with screen basket lip troughs to retain water and minimize vortex stress (CHGEC 1999). As each screen panel rotates out of the intake bay, impinged fish are retained in water-filled baskets at the bottom of each panel and are carried over the headshaft, where they are washed out onto a mesh using low-pressure sprays from the rear side of the machine. The 0.25-by-0.5-inch (in.) (0.635-by-1.27 centimeters (cm)) mesh is smooth to minimize fish abrasion by the mesh. Two high-pressure sprays remove debris from the front side of the machine after fish removal. From the mesh, fish return to the river via a 12-in. (30-cm) diameter pipe. For IP2, the pipe extends 200 ft (61.0 m) into the river north of the IP2 intake structure and discharges at a depth of 35 ft (11 m). The sluice system is a 12-in.-diameter (30.5-cm-diameter) pipe that discharges fish into the river at a depth of 35 ft (10.7 m), 200 ft (61 m) from shore (CHGEC 1999). The IP3 fish return system discharges to the river by the northwest corner of the discharge canal.

Studies indicated that, assuming the screens continued to operate as they had during laboratory and field testing, the screens were "the screening device most likely to impose the least mortalities in the rescue of entrapped fish by mechanical means" (Fletcher 1990). The same study concluded that refinements to the screens would be unlikely to greatly reduce fish kills. No monitoring is currently ongoing at IP2 or IP3 for impingement or entrainment or to ensure that the screens are operating per design standards. Additionally, there is no monitoring ongoing to quantify any actual incidental take of shortnose sturgeon or their prey. The proposed action under consultation, as currently defined by NRC, does not provide for any monitoring of direct or indirect effects to shortnose sturgeon.

After moving through the condensers, cooling water is discharged to the discharge canal via a total of six 96-in. (240-cm) diameter pipes. The cooling water enters below the surface of the 40-ft (12-m) wide canal. The canal discharges to the Hudson River through an outfall structure located south of IP3 at about 4.5 feet per second (fps) (1.4 meters per second (mps)) at full flow. As the discharged water enters the river, it passes through 12 discharge ports (4-ft by 12-ft each (1-m by 3.7-m)) across a length of 252 ft (76.8 m) about 12 ft (3.7 m) below the surface of the river. The increased discharge velocity, about 10 fps (3.0 mps), is designed to enhance mixing to minimize thermal impact.

The discharged water is at an elevated temperature, and therefore, some water is lost because of evaporation. Based on conservative estimates, NRC estimates that this induced evaporation resulting from the elevated discharge temperature would be less than 60 cfs (27,000 gpm or 1.7 m3/s). This loss is about 0.5 percent of the annual average downstream flow of the Hudson River, which is more than 9000 cfs (4 million gpm or 255 m3/s). The average cooling water transient time ranges from 5.6 minutes for the IP3 cooling water system to 9.7 minutes for the IP2 system. Auxiliary water systems for service water are also provided from the Hudson River via the dedicated bays in the IP2 and IP3 intake structures. The primary role of service water is to cool components (e.g., pumps) that generate heat during operation. Secondary functions of the service water include the following:

- protect equipment from potential contamination from river water by providing cooling to intermediate freshwater systems;
- provide water for washing the modified Ristroph traveling screens; and,
- provide seal water for the main circulating water pumps.

Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." IP2 and IP3 are located on a 239-acre (97-hectare) site on the eastern bank of the Hudson River in the village of Buchanan, Westchester County, New York, about 24 miles (mi) (39 kilometers [km] north of New York City, New York (Figures 1 and 2). The direct and indirect effects of the Indian Point facility are the intake of water from the Hudson River and the discharge of heated effluent back into the Hudson River. Therefore, the action area for this consultation includes the intake areas of IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3 as described in the Effects of the Action section below.

LISTED SPECIES IN THE ACTION AREA

The only endangered or threatened species under NMFS' jurisdiction in the Action Area is the endangered shortnose sturgeon (*Acipenser brevirostrum*). No critical habitat has been designated for shortnose sturgeon.

Shortnose sturgeon life history

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[2] when the freshwater temperatures increase to 8-9°C. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female and a mean of 11,568 eggs/kg body weight (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles

2 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

(Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Dispersal rates differ at least regionally, laboratory studies on Connecticut River larvae indicated dispersal peaked 7-12 days after hatching in comparison to Savannah River larve that had longer dispersal rates with multiple, prolonged peaks, and a low level of downstream movement that continued throughout the entire larval and early juvenile period (Parker 2007). Synder (1988) and Parker (2007) considered individuals to be juvenile when they reached 57mm TL. Laboratory studies demonstrated that larvae from the Connecticut River made this transformation on day 40 while Savannah River fish made this transition on day 41 and 42 (Parker 2007).

The juvenile phase can be subdivided in to young of the year (YOY) and immature/ sub-adults. YOY and sub-adult habitat use differs and is believed to be a function of differences in salinity tolerances. Little is known about YOY behavior and habitat use, though it is believed that they are typically found in channel areas within freshwater habitats upstream of the saltwedge for about one year (Dadswell et al. 1984, Kynard 1997). One study on the stomach contents of YOY revealed that the prey items found corresponded to organisms that would be found in the channel environment (amphipods) (Carlson and Simpson 1987). Sub-adults are typically described as age one or older and occupy similar spatio-temporal patterns and habitat-use as adults (Kynard 1997). Though there is evidence from the Delaware River that sub-adults may overwinter in different areas than adults and no not form dense aggregations like adults (ERC Inc. 2007). Sub-adults feed indiscriminately, typical prey items found in stomach contents include aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Dadswell 1979, Carlson and Simpson 1987, Bain 1997).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures reach between 7-9.7°C, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 15°, and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell et al. 1984; Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0°C (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles or sub-adults tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes and move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney et al. 1992; Rogers et al. 1994; Rogers and Weber 1995; Weber 1996).

While shortnose sturgeon do not undertake the significant marine migrations seen in Atlantic sturgeon, telemetry data indicates that shortnose sturgeon do make localized coastal migrations. This is particularly true within certain areas such as the Gulf of Maine (GOM) and among rivers in the Southeast. Interbasin movements have been documented among rivers within the GOM and between the GOM and the Merrimack, between the Connecticut and Hudson rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3°C (Dadswell et al. 1984) and as high as 34°C (Heidt and Gilbert 1978). However, temperatures above 28°C are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28-30°C during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. Dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m but are generally found in waters less than 20m (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989); however, shortnose sturgeon forage on vegetated mudflats and over shellfish beds in shallower waters when suitable forage is present.

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were "in peril...gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[3] of shortnose sturgeon under the ESA. Although genetic information

3 The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (2005), also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St.

John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, United States Geological Survey, personal communication; Dionne 2010), while the largest populations are found in the Saint John (~18, 000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel et al. 1992; Collins et al. 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to riverine habitat which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e. PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28°C. Flourney et al.(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney et al. 1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28°C (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

Global climate change may affect shortnose sturgeon in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers, possibly affecting the survival of drifting larvae and YOY shortnose sturgeon that are sensitive to elevated salinity. Similarly, for river systems with dams, YOY may experience a habitat squeeze between a shifting (upriver) salt wedge and a dam causing loss of available habitat for this life stage.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. One might expect range extensions to shift northward (i.e. into the St. Lawrence River, Canada) while truncating the southern distribution. Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all shortnose sturgeon life stages, including adults, may become susceptible to strandings. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat.

Implications of climate change to shortnose sturgeon throughout their range have been speculated, yet no scientific data are available on past trends related to climate effects on this species and current scientific methods are not able to reliably predict the future magnitude of climate change and associated impacts or the adaptive capacity of this species. While there is a reasonable degree of certainty that certain climate change related effects will be experienced globally (e.g., rising temperatures and changes in precipitation patterns), due to a lack of scientific data, the specific effects to shortnose sturgeon that may result from climate change are not predictable or quantifiable at this time. Information on current effects of global climate change on shortnose sturgeon is not available and while it is speculated that future climate change may affect this species, it is not possible to quantify the extent to which effects may occur. Further analysis on the likely effects of climate change on shortnose sturgeon in the action area is included in the Environmental Baseline and Cumulative Effects sections below.

Status of Shortnose Sturgeon in the Hudson River

The action area is limited to the reach of the Hudson River affected by project operations as described in the "Action Area" section above. As such, this section will discuss the available information related to the presence of shortnose sturgeon in the Hudson River.

Shortnose sturgeon were first observed in the Hudson River by early settlers who captured them as a source of food and documented their abundance (Bain et al. 1998). Shortnose sturgeon in the Hudson River were documented as abundant in the late 1880's (Ryder 1888 in Hoff 1988). Prior to 1937, a few fishermen were still commercially harvesting shortnose sturgeon in the Hudson River; however, fishing pressure declined as the population decreased. During the late 1800s and early 1900s, the Hudson River served as a dumping ground for pollutants that lead to major oxygen depletions and resulted in fish kills and population reductions. During this same time there was a high demand for shortnose sturgeon eggs (caviar), leading to overharvesting. Water pollution, overfishing, and the commercial Atlantic sturgeon fishery are all factors that may have contributed to the decline of shortnose sturgeon in the Hudson River (Hoff 1988).

In the 1930s, the New York State Biological Survey launched the first scientific analysis that documented the distribution, age, and size of mature shortnose sturgeon in the Hudson River (see Bain et al. 1998). In the 1970s, scientific sampling resumed precipitated by the lack of biological data and concerns about the impact of electric generation facilities on fishery resources (see Bain et al. 1998). The current population of shortnose sturgeon has been documented by studies conducted throughout the entire range of shortnose sturgeon in the Hudson River (see: Dovel 1979, Hoff et al. 1988, Geoghegan et al. 1992, Bain et al. 1998, Bain et al. 2000, Dovel et al. 1992).

Several population estimates were conducted throughout the 1970s and 1980s (Dovel 1979; Dovel 1981; Dovel et al. 1992). Moss recently, Bain et al. (1998) conducted a mark recapture study from 1994 through 1997 focusing on the shortnose sturgeon active spawning stock. Utilizing targeted and dispersed sampling methods, 6,430 adult shortnose sturgeon were captured and 5,959 were marked; several different abundance estimates were generated from this sampling data using different population models. Abundance estimates generated ranged from a low of 25, 255 to a high of 80,026; though 61,057 is the abundance estimate from this dataset and modeling exercise that is typically used. This estimate includes spawning adults estimated to comprise 93% of the entire population or 56,708, non-spawning adults accounting for 3% of the population and juveniles 4% (Bain et al. 2000). Bain et al. (2000) compared the spawning population estimate with estimates by Dovel et al. (1992) concluding an increase of approximately 400% between 1979 and 1997. Although fish populations dominated by adults are not common for most species, there is no evidence that this is atypical for shortnose sturgeon (Bain et al. 1998).

Woodland and Secor (2007) examined the Bain et al. (1998, 2000, 2007) estimates to try and identify the cause of the major change in abundance. Woodland and Secor (2007) concluded that the dramatic increase in abundance was likely due to improved water quality in the Hudson River which allowed for high recruitment during years when environmental conditions were right, particularly between 1986-1991. These studies provide the best information available on the current status of the Hudson River population and suggests that the population is relatively healthy, large, and particular in habitat use and migratory behavior (Bain et al. 1998).

Shortnose sturgeon have been documented in the Hudson River from upper Staten Island (RM -3) to the Troy Dam (RM 155; for reference, Indian Point is located at RM 38 (rkm 61))[4] (Bain et al. 2000, ASA 1980-2002). Prior to the construction of the Troy Dam in 1825, shortnose

4 See Figure 1 for a map of the Hudson River with these areas highlighted.

sturgeon are thought to have used the entire freshwater portion of the Hudson River (NYHS 1809). Spawning fish congregated at the base of Cohoes Falls where the Mohawk River emptied into the Hudson. In recent years (since 1999), shortnose sturgeon have been documented below the Tappan Zee Bridge from June through December (ASA 1999-2002; Dynegy 2003). While shortnose sturgeon presence below the Tappan Zee Bridge had previously been thought to be rare (Bain et al. 2000), increasing numbers of shortnose sturgeon have been documented in this area over the last several years (ASA 1999-2002; Dynegy 2003) suggesting that the range of shortnose sturgeon is extending downstream. Shortnose sturgeon were documented as far south as the Manhattan/Staten Island area in June, November and December 2003 (Dynegy 2003).

From late fall to early spring, adult shortnose sturgeon concentrate in a few overwintering areas. Reproductive activity the following spring determines overwintering behavior. The largest overwintering area is just south of Kingston, NY, near Esopus Meadows (rkm 139-152) (Dovel et al. 1992). The fish overwintering at Esopus Meadows are mainly spawning adults. Recent capture data suggests that these areas may be expanding (Hudson River 1999-2002, Dynegy 2003). Captures of shortnose sturgeon during the fall and winter from Saugerties to Hyde Park (greater Kingston reach), indicate that additional smaller overwintering areas may be present (Geoghegan et al. 1992). Both Geoghegan et al. (1992) and Dovel et al. (1992) also confirmed an overwintering site in the Croton-Haverstraw Bay area (rkm 54-61). The Indian Point facility is located at the northern extent of this overwintering area near rkm 61. Fish overwintering in areas below Esopus Meadows are mainly thought to be pre-spawning adults. Typically, movements during overwintering periods are localized and fairly sedentary.

In the Hudson River, males usually spawn at approximately 3-5 years of age while females spawn at approximately 6-10 years of age (Dadswell et al. 1984; Bain et al. 1998). Males may spawn annually once mature and females typically spawn every 3 years (Dovel et al. 1992). Mature males feed only sporadically prior to the spawning migration, while females do not feed at all in the months prior to spawning.

In approximately late March through mid-April, when water temperatures are sustained at 8°-9° C for several days[5], reproductively active adults begin their migration upstream to the spawning grounds that extend from below the Federal Dam at Troy to about Coeymans, NY (rkm 245-212; located more than 150km upstream from the Indian Point facility) (Dovel et al. 1992). Spawning typically occurs at water temperatures between 10-18°C (generally late April-May) after which adults disperse quickly down river into their summer range. Dovel et al. (1992) reported that spawning fish tagged at Troy were recaptured in Haverstraw Bay in early June. The broad summer range occupied by adult shortnose sturgeon extends from approximately rkm 38 to rkm 177. The Indian Point facility is located within the broad summer range.

There is scant data on actual collection of early life stages of shortnose sturgeon in the Hudson River. During a mark recapture study conducted from 1976-1978, Dovel et al. (1979) captured

5 Based on information from the USGS gage in Albany (gage no. 01359139), in 2002 water temperatures reached 8°C on April 10 and 15°C on April 20; 2003 - 8°C on April 14 and 15°C on May 19; 2004 - 8°C on April 17 and 15°C on May 11. In 2011, the most recent year on record, water temperatures reached 8C on April 11 and reached 15C on May 19.

larvae near Hudson, NY (rkm 188) and young of the year were captured further south near Germantown. Between 1996 and 2004, approximately 10 small shortnose sturgeon were collected each year as part of the Falls Shoals Survey (FSS) (ASA 2007). Based upon basic life history information for shortnose sturgeon it is known that eggs adhere to solid objects on the river bottom (Buckley and Kynard 1981; Taubert 1980) and that eggs and larvae are expected to be present within the vicinity of the spawning grounds (rkm 245-212) for approximately four weeks post spawning (i.e., at latest through mid-June). Shortnose sturgeon larvae in the Hudson River generally range in size from 15 to 18 mm TL at hatching (Pekovitch 1979). Larvae gradually disperse downstream after hatching, entering the tidal river (Hoff et al. 1988). Larvae or fry are free swimming and typically concentrate in deep channel habitat (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer ad Kynard 1993). Given that fry are free swimming and foraging, they typically disperse downstream of spawning/rearing areas. Larvae are found throughout the Hudson River estuary and are most commonly found in deep waters with strong currents, typically in the channel (Hoff et al. 1988; Dovel et al. 1992). The transition from the larval to juvenile stage generally occurs in the first summer of life when the fish grows to approximately 2 cm TL and is marked by fully developed external characteristics (Pekovitch 1979).

Similar to non-spawning adults, most juveniles occupy the broad region of Haverstraw Bay (RM 34-40; Indian Point is located near the northern edge of the bay) (Dovel et al. 1992; Geoghegan et al. 1992) by late fall and early winter. Migrations from the summer foraging areas to the overwintering grounds are triggered when water temperatures fall to 8°C (NOAA Fisheries 1998), typically in late November[6]. Juveniles are distributed throughout the mid-river region during the summer and move back into the Haverstraw Bay region during the late fall (Bain et al. 1998; Geoghegan et al. 1992; Haley 1998).

Shortnose sturgeon are bottom feeders and juveniles may use the protuberant snout to "vacuum" the river bottom. Curran & Ries (1937) described juvenile shortnose sturgeon from the Hudson River as having stomach contents of 85-95% mud intermingled with plant and animal material. Other studies found stomach contents of adults were solely food items, implying that feeding is more precisely oriented. The ventral protrusable mouth and barbells are adaptations for a diet of small live benthic animals. Juveniles feed on smaller and somewhat different organisms than adults. Common prey items are aquatic insects (chironomids), isopods, and amphipods. Unlike adults, mollusks do not appear to be an important part of the diet of juveniles (Bain 1997). As adults, their diet shifts strongly to mollusks (Curran & Ries 1937).

Telemetry data has been instrumental in informing the extent of shortnose sturgeon coastal migrations. Recent telemetry data from the Gulf of Maine indicate shortnose sturgeon in this region undertake significant coastal migrations between larger river systems and utilize smaller coastal river systems during these interbasin movements (Fernandes 2008; UMaine unpublished data). Some outmigration has been documented in the Hudson River, albeit at low levels in

6 In 2002, water temperatures at the USGS gage at Hastings-on-Hudson (No. 01376304; the farthest downstream gage on the river) fell to 8°C on November 23. In 2003, water temperatures at this gage fell to 8°C on November 29; In 2010, water temperatures at the USGS gage at West Point, NY (No. 01374019; currently the farthest downstream gage on the river) fell to 8C on November 23.

comparison to coastal movement documented in the Gulf of Maine and Southeast rivers. Two individuals tagged in 1995 in the overwintering area near Kingston, NY were later recaptured in the Connecticut River. One of these fish was at large for over two years and the other 8 years prior to recapture. As such, it is reasonable to expect some level of movement out of the Hudson into adjacent river systems; however, based on available information it is not possible to predict what percentage of adult shortnose sturgeon originating from the Hudson River may participate in coastal migrations.

ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area.

Federal Actions that have Undergone Formal or Early Section 7 Consultation

The only Federal actions that occur within the action area are the operations of the Indian Point facility and research activities authorized pursuant to Section 10 of the ESA.

Impacts of the Historical Operation of the Indian Point Facility

IP1 and IP2 have been operational since the mid-1970s. During this time, shortnose sturgeon in the Hudson River have been exposed to effects of this facility. Eggs and early larvae would be the only life stages of shortnose sturgeon small enough to be vulnerable to entrainment at the Indian Point intakes (openings in the wedge wire screens are 6mm x 12.5 mm (0.25 inches by 0.5 inches); eggs are small enough to pass through these openings but, as explained below, do not occur in the action area.

In the Hudson River, shortnose sturgeon eggs are only found at the spawning grounds, which are more than 150km upstream from the Indian Point intakes (Bain 1998; NMFS 1998). As no shortnose sturgeon eggs occur in the action area, no entrainment of shortnose sturgeon eggs would be anticipated. Shortnose sturgeon larvae are found in deep channels, typically above the salt wedge (Buckley and Kynard 1985). In the Hudson River the location of the salt wedge can vary from as far north as Poughkeepsie to as far downstream as Hastings on Hudson (USGS Hudson River Salt Front study webpage) and therefore, could be upstream or downstream of Indian Point. Depending on the location of the saltwedge, in some years salinity may be low enough in the action area for shortnose sturgeon larvae to be present. In laboratory experiments, larvae were nocturnal, and preferred deep water, grey color, and a silt substrate (Richmond and Kynard 1995). Larvae collected in rivers were found in the deepest water, usually within the channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae in the Hudson River are expected to occur in the deep channel (Hoff et al. 1988; Dovel et al. 1992), which is at least 2,000 feet from the intakes. Any larvae in the action area are expected to be at least 20mm in length as that is the size that shortnose sturgeon larvae begin downstream migrations (Buckley and Kynard 1995); while body width measurements are not available, it is possible that some larvae would be small enough to pass through the screen mesh. However, as larvae are typically found in the deep channel, which is more than 2,000 feet from the location of the intakes, it is unlikely that larvae would be entrained in the intakes.

Studies to evaluate the effects of entrainment at IP2 and IP3 occurred from the early 1970s through 1987; with intense daily sampling during the spring of 1981-1987. As reported by NRC in the FEIS and BA, entrainment monitoring reports list no shortnose sturgeon eggs or larvae at IP2 or IP3. Given what is known about these life stages (i.e., no eggs present in the action area; larvae only expected to be found in the deep channel area away from the intakes) and the intensity of the past monitoring, it is reasonable to assume that this past monitoring provides an accurate assessment of past entrainment of shortnose sturgeon early life stages. Based on this, it is unlikely that any entrainment of shortnose sturgeon eggs and larvae occurred historically.

The impingement of shortnose sturgeon at IP2 and IP3 has been documented. Impingement monitoring, described fully below in the "Effects of the Action" section, occurred from 1974-1990, during this time period 21 shortnose sturgeon were observed impinged at IP2. Length is available for 6 fish and ranged from 320-710mm. Condition (dead or alive) is also only available for 6 fish, with 5 of the 6 fish reported dead. However, no information on the condition of these fish is available, thus it is not possible to speculate as to whether these fish were fresh dead or died previously and drifted into the intakes. For Unit 3, 11 impinged shortnose sturgeon were recorded. Condition is available for 3 fish, with two of the three dead. Length is also only available for three fish, with lengths of 325, 479 and 600 mm. Water temperatures at the time of recovery ranged from 0.5 – 28°C. Collectively at IP2 and IP3, impingements occurred in all months except July and December.

While models of the current thermal plume are available, it is not clear whether this model accurately represents past conditions associated with the thermal plume. As no information on past thermal conditions are available and no monitoring was done historically to determine if the thermal plume was effecting shortnose sturgeon or their prey, it is not possible to estimate past effects associated with the discharge of heated effluent from the Indian Point facility. No information is available on any past impacts to shortnose sturgeon prey due to impingement or entrainment or exposure to the thermal plume. This is because no monitoring of shortnose sturgeon prey in the action area has occurred.

Hudson River Power Plants

The mid-Hudson River provided the cooling water for four other power plants in addition to Indian Point (RM 38): Roseton Generating Station (RM 66), Danskammer Point Generating Station (RM 67), Bowline Point Generating Station (RM 33), and Lovett Generating Station (RM 38); all four stations are fossil-fueled steam electric stations, located on the western shore of the river, and all use once-through cooling. Roseton consists of two units and is located at RM 66 (RKM 106), 23 mi (37 km) north of IP2 and IP3. Just 0.5 mi (0.9 km) north of Roseton is Danskammer, with four units. Bowline lies about five mi (eight km) south of IP2 and IP3 and consists of two units (Entergy 2007a; CHGEC 1999). Lovett, almost directly across the river from IP2 and IP3, is no longer operating.

In 1998, Central Hudson Gas and Electric Corporation (CHGEC), the operator of the Roseton and Danskammer Point power plants initiated an application for a permit under section 10(a)(1)(B) of the ESA.[7] As part of this process CHGEC submitted a Conservation Plan and application for a 10(a)(1)(B) incidental take permit that proposed to minimize the potential for entrainment and impingement of shortnose sturgeon at the Roseton and Danskammer Point power plants. These measures ensure that the operation of these plants will not appreciably reduce the likelihood of the survival and recovery of shortnose sturgeon in the wild. In addition to the minimization measures, a proposed monitoring program was implemented to assess the periodic take of shortnose sturgeon, the status of the species in the project area, and the progress on the fulfillment of mitigation requirements. In December 2000, Dynegy Roseton L.L.C. and Dynegy Danskammer Point L.L.C. were issued incidental take permit no. 1269 (ITP 1269).

The ITP exempts the incidental take of 2 shortnose sturgeon at Roseton and 4 at Danskammer Point annually. This incidental take level is based upon impingement data collected from 1972-1998. NMFS determined that this level of take was not likely to appreciably reduce the numbers, distribution, or reproduction of the Hudson River population of shortnose sturgeon in a way that appreciably reduces the ability of shortnose sturgeon to survive and recover in the wild. Since the ITP was issued, the number of shortnose sturgeon impinged has been very low. Dynegy has indicated that this may be due in part to reduced operations at the facilities which results in significantly less water withdrawal and therefore less opportunity for impingement. While historical monitoring reports indicate that a small number of sturgeon larvae were entrained at Danskammer, no sturgeon larvae have been observed in entrainment samples collected since the ITP was issued.

Scientific Studies

The Hudson River population of shortnose sturgeon have been the focus of a prolonged history of scientific research. In the 1930s, the New York State Biological Survey launched the first scientific sampling study and documented the distribution, age, and size of mature shortnose sturgeon (Bain et al. 1998). In the early 1970s, research resumed in response to a lack of biological data and concerns about the impact of electric generation facilities on fishery resources (Hoff 1988). In an effort to monitor relative abundance, population status, and distribution, intensive sampling of shortnose sturgeon in this region has continued throughout the past forty years. Sampling studies targeting other species also incidentally capture shortnose sturgeon.

There are currently three shortnose sturgeon scientific research permits issued pursuant to Section 10(a)(1)(A) of the ESA, in the Hudson River. NYDECs' scientific research permit (#1547) authorizes DEC to conduct river surveys in the Hudson River, specifically focusing on Haverstraw Bay and Newburgh areas to evaluate the seasonal movements of adults and juveniles. NYDEC is authorized to capture up to 500 adults/juveniles annually in order to weigh, measure, tag, and collect tissue samples for genetic analyses. Permit # 1547 expires October 31, 2011.

Scientific research permit # 1575 authorizes Earth Tech, Inc. to conduct a study of fisheries resources in and around the Tappan Zee Bridge in support of the NY Department of

7 CHGEC has since been acquired by Dynegy Danskammer L.L.C. and Dynegy Roseton L.L.C. (Dynegy), thus the current incidental take permit is held by Dynegy.

Transportation, NY Thruway Authority, and the Metro-North Railroad efforts to improve the mobility in the I-287 corridor including the potential replacement of the Tappan Zee Bridge. Data collection is focused on fish assemblages and relative species abundance in the vicinity of the bridge. Earth Tech, Inc. is authorized to capture, handle, and measure up to 250 adult/juvenile shortnose sturgeon annually. Permit # 1575 expires November 30, 2011.

The third scientific research permit (#1580, originally issued as #1254) is issued to Dynegy to evaluate the life history, population trends, and spacio-temporal and size distribution of shortnose sturgeon collected during the annual Hudson River Biological Monitoring Program. Dynegy is authorized to capture up to 82 adults/juveniles annually to measure, weigh, tag, photograph, and collect tissue samples for genetic analyses. Dynegy is also authorized to lethally take up to 40 larvae annually. Permit # 1580 will expire on March 31, 2012. These permits are issued for a period of five years and may be renewed pending a formal review by NMFS' Office of Protected Resources, Permits Division.

Impacts of Contaminants and Water Quality
Historically, shortnose sturgeon were rare in the lower Hudson River, likely as a result of poor water quality precluding migration further downstream. However, in the past several years, the water quality has improved and sturgeon have been found as far downstream as the Manhattan/Staten Island area. It is likely that contaminants remain in the water and in the action area, albeit to reduced levels. Sewage, industrial pollutants and waterfront development has likely decreased the water quality in the action area. Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable. Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979).

Principal toxic chemicals in the Hudson River include pesticides and herbicides, heavy metals, and other organic contaminants such as PAHs and PCBs. Concentrations of many heavy metals also appear to be in decline and remaining areas of concern are largely limited to those near urban or industrialized areas. With the exception of areas near New York City, there currently does not appear to be a major concern with respect to heavy metals in the Hudson River, however metals could have previously affected shortnose sturgeon.

PAHs, which are products of incomplete combustion, most commonly enter the Hudson River as a result of urban runoff. As a result, areas of greatest concern are limited to urbanized areas, principally near New York City. The majority of individual PAHs of concern have declined during the past decade in the lower Hudson River and New York Harbor.

PCBs are the principal toxic chemicals of concern in the Hudson River. Primary inputs of PCBs in freshwater areas of the Hudson River are from the upper Hudson River near Fort Edward and Hudson Falls, New York. In the lower Hudson River, PCB concentrations observed are a result of both transport from upstream as well as direct inputs from adjacent urban areas. PCBs tend to be bound to sediments and also bioaccumulate and biomagnify once they enter the food chain.

This tendency to bioaccumulate and biomagnify results in the concentration of PCBs in the tissue concentrations in aquatic-dependent organisms. These tissue levels can be many orders of magnitude higher than those observed in sediments and can approach or even exceed levels that pose concern over risks to the environment and to humans who might consume these organisms. PCBs can have serious deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). PCB's may also contribute to a decreased immunity to fin rot (Dovel et al. 1992). Large areas of the upper Hudson River are known to be contaminated by PCBs and this is thought to account for the high percentage of shortnose sturgeon in the Hudson River exhibiting fin rot. Under a statewide toxics monitoring program, the NYSDEC analyzed tissues from four shortnose sturgeon to determine PCB concentrations. In gonadal tissues, where lipid percentages are highest, the average PCB concentration was 29.55 parts per million (ppm; Sloan 1981) and in all tissues ranged from 22.1 to 997.0 ppm. Dovel (1992) reported that more than 75% of the shortnose sturgeon captured in his study had severe incidence of fin rot.

In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). Manufactured Gas Product (MGP) waste, which is chemically similar to the coal tar deposits found in the Connecticut River, is known to occur at several sites within the Hudson River and this waste may have had similar effects on any shortnose sturgeon present in the action area over the years.

Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

Heavy usage of the Hudson River and development along the waterfront could have affected shortnose sturgeon throughout the action area. Coastal development and/or construction sites often result in excessive water turbidity, which could influence sturgeon spawning and/or foraging ability. Industries along the Hudson River have likely impacted the water quality, as service industries, such as transportation, communication, public utilities, wholesale and retail trades, finance, insurance and real estate, repair and others, have increased since 1985 in all nine counties in the lower Hudson River.

The Hudson River is used as a source of potable water, for waste disposal, transportation and cooling by industry and municipalities. Rohman et al. (1987) identified 183 separate industrial and municipal discharges to the Hudson and Mohawk Rivers. The greatest number of users were in the chemical industry, followed by the oil industry, paper and textile manufactures, sand, gravel, and rock processors, power plants, and cement companies. Approximately 20 publicly owned treatment works discharge sewage and wastewater into the Hudson River. Most of the municipal wastes receive primary and secondary treatment. A relatively small amount of sewage is attributed to discharges from recreational boats.

As explained above, the shortnose sturgeon population in the Hudson River is the largest shortnose sturgeon population in the U.S. Studies conducted in the late 1990s indicate that the population may have increased 400% compared to previous studies. The available information indicates that despite facing threats such as power plant entrainments, water quality and in-water construction, the population experienced considerable growth between the late 1970s and late 1990s and is considered to be at least stable at high levels (Woodland and Secor 2007).

Global climate change

The global mean temperature has risen 0.76°C over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a) and precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b); these trends are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3°-5°C (5°-9°F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2°C per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene et al. 2008).

The past 3 decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene et al. 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene et al. 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene et al. 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene et al. 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Hudson River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the United States. Additional information on potential effects of climate change specific to the action area is discussed below. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000); therefore, it is also expected to continue during the course of the renewed licenses (20 years), if issued. It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that they will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch et al. 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch et al. 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer et al. 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer et al. 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2°C per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm.

Effects on shortnose sturgeon throughout their range
Shortnose sturgeon have persisted for millions of years and throughout this time have experienced wide variations in global climate conditions and have successfully adapted to these changes. As such, climate change at normal rates (thousands of years) is not thought to have historically a problem shortnose sturgeon. Shortnose sturgeon could be affected by changes in river ecology resulting from increases in precipitation and changes in water temperature which may affect recruitment and distribution in these rivers. However, as noted in the "Status of the Species" section above, information on current effects of global climate change on shortnose sturgeon is not available and while it is speculated that future climate change may affect this species, it is not possible to quantify the extent to which effects may occur. However, effects of climate change in the action area during the temporal scope of this section 7 analysis (the license renewal periods for IP2/IP3: September 2013 to September 2033 and December 2015 to December 2035) on shortnose sturgeon in the action area are discussed below.

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Hudson River largely focuses on effects that rising water levels may have on the human environment. The New York State Sea Level Rise Task Force (Spector in Bhutta 2010) predicts a state-wide sea level rise of 7-52 inches by the end of this century, with the conservative range being about 2 feet. This compares to an average sea level rise of about 1 foot in the Hudson Valley in the past 100 years. Sea level rise is expected to result in the northward movement of the salt wedge. The location of the salt wedge in the Hudson River is highly variable depending on season, river flow, and precipitation so it is unclear what effect this northward shift could have. Potential negative effects include restricting the habitat available for juvenile shortnose sturgeon which are intolerant to salinity and are present exclusively upstream of the salt wedge. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shift that may occur.

Air temperatures in the Hudson Valley have risen approximately 0.5°C since 1970. In the 2000s, the mean Hudson river water temperature, as measured at the Poughkeepsie Water Treatment Facility, was approximately 2°C higher than averages recorded in the 1960s (Pisces 2008). However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Hudson River generally. The Pisces report (2008) also states that temperatures within the Hudson River may be becoming more extreme. For example, in 2005, water temperature on certain dates was close to the maximum ever recorded and also on other dates reached the lowest temperatures recorded over a 53-year period. Other conditions that may be related to climate change that have been reported in the Hudson Valley are warmer winter temperatures, earlier melt-out and more severe flooding. An average increase in precipitation of about 5% is expected; however, information on the effects of an increase in precipitation on conditions in the action area is not available.

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose sturgeon. The most likely effect to shortnose sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north which would restrict the range of juvenile shortnose sturgeon and may affect the development of these life stages. In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of spawning, which would result in a change in the seasonal distribution of sturgeon in the action area. A northward shift in the salt wedge could also drive spawning shortnose sturgeon further upstream which may result in a restriction in the spawning range and an increase in the number of spawning shortnose sturgeon in the action area, as this area is the furthest accessible upstream spawning area.

As described above, over the long term, global climate change may affect shortnose sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality; however, there is significant uncertaintity, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which shortnose sturgeon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect shortnose sturgeon in the action area. Scientific data on changes in shortnose sturgeon distribution and behavior in the action area is not available. Therefore, it is not possible to say with any degree of certainty whether and how their distribution or behavior in the action area have been or are currently affected by climate change related impacts. Implications of potential changes in the action area related to climate change are not clear in terms of population level impacts, data specific to these species in the action area are lacking. Therefore, any recent impacts from climate change in the action area are not quantifiable or describable to a degree that could be meaningfully analyzed in this consultation. However, given the likely rate of climate change, it is unlikely that there will be significant effects to shortnose sturgeon in the action area, such as changes in distribution or abundance, over the time period considered in this consultation (i.e., 2013 through 2035) and it is unlikely that shortnose sturgeon in the action area will experience new climate change related effects not already captured in the "Status of the Species" section above concurrent with the proposed action.

EFFECTS OF THE ACTION

This section of a Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects of the proposed action on shortnose sturgeon and their habitat in the action area within the context of the species current status, the environmental baseline and cumulative effects. The effects of the proposed action are the effects of the continued operation of IP2 and IP3 pursuant to renewed licenses proposed to be issued by the NRC pursuant to the Atomic Energy Act. NRC has requested consultation on the proposed extended operation of the facilities under the same terms as in the existing licenses and existing SPDES permits.

The proposed action has the potential to affect shortnose sturgeon in several ways: impingement or entrainment of individual shortnose sturgeon at the intakes; altering the abundance or availability of potential prey items; and, altering the riverine environment through the discharge of heated effluent.

Effects of Water Withdrawal

Under the terms of the proposed renewal license, IP2 and IP3 will withdraw water from the Hudson River for cooling. Both units would utilize once through cooling, assuming no changes are made to the proposed action. Section 316(b) of the Clean Water Act requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. According to the draft SPDES permit for the facility, the NYDEC has determined for Clean Water Act purposes that the site-specific best technology available to minimize the adverse environmental impacts of the IP cooling water intake structures is closed-cycle cooling (NYDEC 2003b). IP2 and IP3 currently operate pursuant to the terms of the SPDES permits issued by NYDEC in 1987 but administratively extended since then. NYDEC issued a draft SPDES permit in 2003. Its final contents and timeframe for issuance are uncertain, given it is still under adjudication at this time. While it is also uncertain that the facility will be able to operate under the same terms as those in its existing license and SPDES permit, NRC sought consultation on its proposal to renew the license for the facility under the same terms as the existing license and SPDES permit, which authorize once through cooling. NMFS will consider the impacts to shortnose sturgeon of the continued operation of IP2 and IP3 with the existing once through cooling system and existing SPDES permits over the duration of the proposed license renewal period for IP2 and IP3 (i.e., September 2013 to September 2033 and December 2015 to December 2035, respectively). But, it is important to note that changes to the effects of the action, including but not limited to changes in the effects of the cooling water system, as well as changes in other factors, may trigger reinitiation of consultation (see 50 CFR 402.16).

Entrainment of Shortnose sturgeon

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects organisms with limited swimming ability that can pass through the screen mesh, used on the intake systems. Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000 in NRC 2011). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

The southern extent of the shortnose sturgeon spawning area in the Hudson River is approximately RM 118 (RKM 190), approximately 75 RM (121 RKM) upstream of the intake of IP2 and IP3. The eggs of shortnose sturgeon are demersal, sinking and adhering to the bottom of the river, and, upon hatching the larvae in both yolk-sac and post-yolk-sac stages remain on the bottom of the river, primarily upstream of RM 110 (RKM 177) (NMFS 2000). Because eggs do not occur near the intake for IP2 and IP3, there is no probability of entrainment. Shortnose sturgeon larvae are 20mm in length at the time they begin downstream migrations (Buckley and Kynard 1995). Larvae are typically found in freshwater, above the salt wedge. The location of the salt wedge in the Hudson River varies both seasonally and annually, depending at least partially on freshwater input. In many years, the salt wedge is located upstream of the Indian Point intakes; in those years, larvae would not be expected to occur near the IP intakes as the salinity levels would be too high. However, at times when the salt wedge is downstream of the intakes, which is most likely to occur in the late summer, there is the potential for shortnose sturgeon larvae to be present in the action area. Larvae occur in the deepest water and in the Hudson River, they are found in the deep channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae grow rapidly and after a few weeks are too large to be entrained by the cooling water intake; thus, any potential for entrainment is limited to any period when individuals are small enough to pass through the openings in the mesh screens that coincide with a period when the salt wedge is located downstream of the intakes. Given the distance between the intake and the deep channel (2000 feet) where any larvae would be present if in the action area, larvae are unlikely to occur near the intake where they could be susceptible to entrainment.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system. IP2 and IP3 monitored entrainment from 1972 through 1987. Entrainment monitoring became more intensive at Indian Point from 1981 through 1987, and sampling was conducted for nearly 24 hours per day, four to seven days per week, during the spawning season in the spring. As reported by NRC, entrainment monitoring reports list no shortnose sturgeon eggs or larvae at IP2 or IP3. During the development of the HCP for steam electric generators on the Hudson River, NMFS reviewed all available entrainment data. In the HCP, NMFS (2000) lists only eight sturgeon larvae collected at any of the mid-Hudson River power plants (all eight were collected at Danskammer (approximately 23 miles upstream of Indian Point), and four of the eight may have been Atlantic sturgeon). Entrainment sampling data supplied by the applicant (Entergy 2007b) include large numbers of larvae for which the species could not be determined; however, NRC has indicated that as sturgeon larvae are distinctive it is unlikely that sturgeon larvae would occur in the "unaccounted" category as it is expected that if there were any sturgeon larvae in these samples they would have been identifiable. Entergy currently is not required to conduct any monitoring program to record entrainment at IP2 and IP3; however, it is reasonable to use past entrainment results to predict future effects. This is because: (1) there have not been any operational changes that make entrainment more likely now than it was during the time when sampling took place; and, (2) the years when intense entrainment sampling took place overlap with two of the years (1986 and 1987; Woodland and Secor 2007) when shortnose sturgeon recruitment is thought to have been the highest and therefore, the years when the greatest numbers of shortnose sturgeon larvae were available for entrainment. The lack of observed entrainment of shortnose sturgeon during sampling at IP2 and IP3 is also reasonable given the known information on the location of shortnose sturgeon spawning and the distribution of eggs and larvae in the river.

Based on the life history of the shortnose sturgeon, the location of spawning grounds within the Hudson River, and the patterns of movement for eggs and larvae, it is extremely unlikely that any shortnose sturgeon early life stages would be entrained at IP2 and/or IP3. This conclusion is supported by the lack of any eggs or larvae positively identified as sturgeon and documented during entrainment monitoring at IP2 or IP3. Provided that assumption is true, NMFS does not anticipate any entrainment of shortnose sturgeon eggs or larvae over the period of the extended operating license (i.e., September 2013 through September 2033 and December 2015 through December 2035). It is important to note that this determination is dependent on the validity of the assumption that none of the unidentified larvae were shortnose sturgeon. All other life stages of shortnose sturgeon are too big to pass through the screen mesh and could not be entrained at the facility.

Impingement of Shortnose Sturgeon

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement can kill organisms immediately or contribute to death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwashing and fish return system that the plant operator uses. Below, NMFS considers the available data on the impingement of shortnose sturgeon at the facility and then considers the likely rates of mortality associated with this impingement.

IP2 and IP3 monitored impingement of most fish species daily until 1981, reduced collections to a randomly selected schedule of 110 days per year until 1991, and then ceased monitoring in 1991 with the installation of the modified Ristroph traveling screens. IP2 and IP3 monitored the impingement of sturgeon species daily from 1974 through 1990 (Entergy 2009).

In 2000, NMFS prepared an environmental assessment (EA) for the proposed issuance of an Incidental Take Permit for shortnose sturgeon at the Roseton and Danskammer generating stations on the Hudson River (NMFS 2000). The EA included the estimated total number of shortnose sturgeon impinged IP2 and IP3, with adjustments to include the periods when sampling was not conducted, including the years after 1990 when no impingement monitoring was conducted. In the EA, NMFS reported that between 1972-1998, an estimated total of 37 shortnose sturgeon were impinged at IP2 and 26 at IP3, with an average of 1.4 and 1.0 fish per year, respectively. For the subset time period of 1989-1998, a total of 8 shortnose sturgeon were estimated to have been impinged at IP2 and 8 at IP3, with an average of 0.8 fish per year at each of the two units.

During the ESA consultation process, NRC worked with Entergy to review the previously reported impingement data and to make mathematical corrections associated with accounting errors related to sampling frequency. The corrected impingement data for shortnose sturgeon show that from 1975 to 1990, 20 fish were impinged at IP2 and 11 fish were impinged at IP3; this indicates an average of 1.3 shortnose sturgeon per year at IP2 and 0.73 shortnose sturgeon per year at IP3. NRC has stated that the installation of the modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement mortality for shortnose sturgeon; however, because no monitoring occurred after the installation of the Ristroph screens, more recent data are not available and,it is not possible to determine to what extent the modified Ristroph screens may have reduced impingement mortality as compared to pre-1991 levels.

According to information provided by Entergy (Mattson, personal communication, August 2011), approach velocities outside of the trash bars at IP2 and IP3 are approximately 1.0fps at full flow and 0.6fps at reduced flow (Entergy 2007); yearling and older shortnose sturgeon are able to avoid intake velocities of this speed (Kynard, personal communication 2004). Shortnose sturgeon that become impinged at IP2 and IP3 are likely vulnerable to impingement due to previous injury or other stressor, given thatindividuals in normal, healthy condition should be able to readily avoid the intakes.The trash bars at the IP2 and IP3 intakes have clear spacing of three inches. Shortnose sturgeon adults and some larger juveniles are expected to have body widths greater than three inches; these fish would be too wide to pass through the bars. Smaller juveniles, which are likely to occur in the vicinity of Indian Point (BBain et al. 1998), with body widths less than 3 inches, would have body widths narrow enough to pass through the trash bars and contact the Ristroph screens.

The shortnose sturgeon population in the Hudson River exhibited tremendous growth in the 20 year period between the late 1970s and late 1990s, with exceptionally strong year classes between 1986-1992 thought to have led to resulting increases in the subadult and adult populations sampled in the late 1990s (Woodland and Secor 2007). The period for which impingement sampling occurred partially overlaps with the period of increased recruitment; however, during the portion of the sampling period that does overlap with the period of increased recruitment (1986-1990) the increases in the shortnose sturgeon population would have been fish less than 4 years old, which represent only a small portion of the overall shortnose sturgeon population. Thus, to predict future impingement rates it is appropriate to adjust the past impingement rates with a correction factor to account for the increased number of shortnose sturgeon in the population. According to data presented by Bain (2000) and Woodland and Secor (2007), there were 4 times as many shortnose sturgeon in the Hudson River in the late 1990s as compared to the late 1970s. There is no figure available for the interim period which would best overlap with the period when impingement sampling occurred. Woodland and Secor state that the population of shortnose sturgeon is currently stable at the high level described also by Bain. Given the four-fold increase in the population, there would be 4 times as many shortnose sturgeon that could be potentially impinged at the facility now as compared to the past monitoring period. Given this, it is reasonable to multiply the past impingement rates by a factor of 4 to predict impingement rates based on the best available population size. Using this method, an impingement rate of 5.2 shortnose sturgeon per year is calculated for IP2 and an impingement rate of 2.9 shortnose sturgeon per year is calculated for IP3. Using this rate, it is estimated that over the 20 year life of the extended operating license, a total of no more than 104 shortnose sturgeon will be impinged at IP2 and no more than 58 shortnose sturgeon will be impinged at IP3. NMFS considered reviewing impingement data for other Hudson River power plants to determine if this predicted correlation between increases in individuals and increased impingement of individuals would be observed. Long term shortnose sturgeon impingement monitoring is only available for the Roseton and Danskammer facilities. However, since 2000 both facilities have operated at reduced rates and there has been minimal shortnose sturgeon impingement. As these facilities are not currently operating in the same capacity they were in the past, it is not possible to make an accurate comparison of past and present impingement which could serve to verify NMFS assumptions about an increase in the number of individual shortnose sturgeon in the Hudson River resulting in an increase in impingement. However, based on the assumption that, all other factors remain the same (approach velocity, intake volume) the likelihood of impingement should increase with an increase in available individuals. As noted above, the Lovett facility has been closed. The Bowline facility has always operated with extremely low levels of impingement, thought to be primarily due to the location of the intakes in a nearly enclosed embayment of the River where shortnose sturgeon are thought to be unlikely to occur (Bowline Pond) (NMFS 2000).

Before installation of modified Ristroph screen systems in 1991, impingement mortality at IP2 and IP3 was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design of the screens, as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at IP2 and IP3. The Fletcher study reported mortality following an 8-hour holding period in an attempt to account for delayed mortality that may result from injuries suffered during impingement. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad, with mortality rates ranging from 9-62%, depending on species. No evaluation of survival of shortnose sturgeon was made. PSEG prepared estimates of impingement survival following interactions with Ristroph screens at their Salem Nuclear Generating Station located on the Delaware River (PSEG in Seabey and Henderson 2007); survival of shortnose sturgeon was estimated at 60% following impingement on a conventional screen and 80% following survival at a Ristroph Screen; survival for other species ranged from 0-100%. In the Indian Point BA, NRC states that the modified Ristroph screen and fish return system at Salem is comparable to that at Indian Point. It is important to note that PSEG did not conduct field verifications with shortnose sturgeon to demonstrate whether these survival estimates are observed in the field. A review by NMFS of shortnose sturgeon impingement information at Salem indicates that all recorded impingements (20 total since 1978; NRC 2010) have been at the trash racks, not on the Ristroph screens. This is consistent with the expectation that all shortnose sturgeon in the vicinity of the Salem intakes would be too large too fit through the trash bars and potentially contact the Ristroph screens. Thus, while there is impingement data from Salem, there is no information on post-impingement survival for shortnose sturgeon impinged on the Ristroph screens. The majority of impinged shortnose sturgeon at Salem have been dead at the time of removal from the trash racks (17 out of 20; 85%),

In his 1979 testimony, Dadswell discussed a mortality rate of shortnose sturgeon at traditional screens of approximately 60%, although it is unclear what information this number is derived from as no references were provided and no explanation was given in the testimony.

No further monitoring of impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991, and any actual reduction in mortality or injury to shortnose sturgeon resulting from impingement after installation of these systems at IP2 and IP3 has not been established. As explained above, shortnose sturgeon with a body width of at least three inches would not be able to pass through the trash bars and would become impinged on the trash bars and not pass through to the Ristroph screens. Survival for shortnose sturgeon impinged on the trash bars would be dependent on the length of time the fish was impinged. The available data for shortnose sturgeon impingement at trash bars indicates that mortality is likely to be high. Of the 32 shortnose sturgeon collected during impingement sampling at IP2 and IP3, condition (alive or dead) is available for 9 fish; of these, 7 are reported as dead. There is no additional information to assess whether these fish were likely killed prior to impingement and drifted into the intake or whether their deaths were a result of impingement. Similar high levels of mortality (85%) are observed at the intakes at the Salem Nuclear facility on the Delaware River. As noted above, healthy shortnose sturgeon (yearlings and older) are expected to be able to readily avoid an intake with an approach velocity of 1.0 fps or less. Therefore, any shortnose sturgeon impinged at the trash bars, where the velocity is 1.0 fps or less depending on operating condition, are likely to already be suffering from injury,or illness which has impaired their swimming ability. As such, mortality rates for shortnose sturgeon impinged on the trash bars are more likely to be as high as 100%.

Based on the available information, it is difficult to predict the likely mortality rate for shortnose sturgeon following impingement on the Ristroph screens. Shortnose sturgeon passing through the trash bars and becoming impinged on the Ristroph screens are likely to be small juveniles with body widths less than three inches. Based on the 8-hour survival rates reported by Fletcher, it is likely that some percentage of shortnose sturgeon impinged on the Ristroph screens will survive. However, given that shortnose sturgeon that become impinged on the Ristroph screens are likely to be suffering from injuries, illnesses, or other stressors that have impaired their swimming ability and prevented them from being able to escape from the relatively low approach velocity (1.0 fps or less as measured within the intake bay in front of the Ristroph screens, which yearling and older shortnose sturgeon are expcted to be able to avoid (Kynard, pers comm.. 2004)), unknowns regarding injuries and subsequent mortality and without any site-specific studies to base an estimate or even species-specific studies at different facilities, NMFS will assume the worst case, that all individual shortnose sturgeon impinged at IP2 and IP3 will die. Thus, using the impingement rates calculated above, an average of 5 shortnose sturgeon may die each year as a result of impingement at IP2 and an average of 3 shortnose sturgeon may die each year as a result of impingement at IP3; for a total of 104 at IP2 and 58 at IP3 over the extended 20-year operating license. However, NMFS believes that the 100% mortality estimate is a conservative, yet reasonable, mortality rate for impinged shortnose sturgeon at the trash bars and Ristroph screens.

Effects of Impingement and Entrainment on Shortnose sturgeon prey
Shortnose sturgeon feed primarily on benthic invertebrates. As these prey species are found on the bottom and are generally immobile or have limited mobility and are not within the water column, they are less vulnerable to impingement or entrainment. Impingement and entrainment studies have not included macroinvertebrates as focus species. No macroinvertebrates are represented in the Representative Important Species (RIS) species focused on by NRC in the FSEIS. However, given the life history characteristics (sessile, benthic, not suspended in or otherwise occupying the water column) of shortnose sturgeon forage items which make impingement and entrainment unlikely, any loss of shortnose sturgeon prey due to impingement or entrainment is likely to be minimal. Therefore, NMFS has determined that the effect on shortnose sturgeon due to the potential loss of forage items caused by impingement or entrainment in the IP2 or IP3 intakes is insignificant and discountable.

Summary of Effects of Water Withdrawal – IP2 and IP3
The extended operation of IP2 and IP3 would be authorized by the NRC through the issuance of renewed operating licenses. Given the facilities with a once-through cooling water system cannot operate without the intake and discharge of water, and any limitations or requirements necessary to assure compliance with applicable Clean Water Act provisions would be conditions of the proposed renewed licenses, the effects of water withdrawals are effects of the proposed action. In the analysis outlined above, NMFS has determined the impingement of shortnose sturgeon is likely to occur at IP2 and IP3 over the extended operating period. NMFS has estimated, using the impingement rates calculated above, that each year an average of 5 shortnose sturgeon may die as a result of impingement at IP2 and an average of 3 shortnose sturgeon may die as a result of impingement at IP3; for a total of 104 at IP2 and 58 at IP3 over the 20 year operating license. NMFS believes that the 100% mortality estimate is a conservative, yet reasonable estimate of the likely mortality rate for impinged shortnose sturgeon at the Ristroph screens. Due to the size of shortnose sturgeon that occur in the action area, no entrainment at IP2

or IP3 is anticipated. Any effects to shortnose sturgeon prey from the continued operation of IP2 and IP3, as defined by the proposed action, would be insignificant and discountable.

Effects of Discharges to the Hudson River

The discharge of pollutants from the IP facility is regulated for Clean Water Act purposes through the New York State Pollution Discharge Elimination System (SPDES) program. The SDPES permit (NY-0004472) specifies the discharge standards and monitoring requirements for each discharge. Under this regulatory program, Entergy treats wastewater effluents, collects and disposes of potential contaminants, and undertakes pollution prevention activities.

As explained above, Entergy's 1987 SPDES permit remains in effect while NYDEC administrative proceedings continue on a new draft permit. As such, pursuant to NRC's request, the effects of the IP facility continuing to operate under proposed renewed licenses and under the terms of the 1987 SPDES permit will be discussed below.

Heated Effluent

As indicated above, the extended operation of IP2 and IP3 would be regulated by the NRC through the issuance of renewed operating licenses. Given the facilities with a once-through cooling water system cannot operate without the intake and discharge of water, and any limitations or requirements necessary to assure compliance with applicable Clean Water Act provisions would be conditions of the proposed renewed licenses, the effects of discharges are effects of the proposed action. Thermal discharges associated with the operation of the once through cooling water system for IP2 and IP3 are regulated for Clean Water Act purposes by the terms of the SPDES permit. Temperature limitations are established and imposed on a case-by-case basis for each facility subject to NYCRR Part 704. Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR Part 704 as follows:

(5) Estuaries or portions of estuaries.

i. The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point.

ii. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or a maximum of 83°F, whichever is less.

iii. From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than an 83°F increase in temperature not to exceed 1.5°F at any point of the estuarine passageway as delineated above, may be permitted.

iv. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than 4°F from the temperature that existed immediately prior to such lowering.

Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified by NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110°F (43°C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2°F (34°C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2°F (34°C) on more than 15 days during that period in any year.

The discharge of heated water has the potential to cause lethal or sublethal effects on fish and other aquatic organisms and create barriers, preventing or delaying access to other areas within the river. Limited information is available on the characteristics of the thermal plume associated with discharges from IP2 and IP3. Below, NMFS summarizes the available information on the thermal plume, discusses the thermal tolerances of shortnose sturgeon, and considers effects of the plume on shortnose sturgeon and their prey.

Characteristics of Indian Point's Thermal Plume
Thermal studies at IP2 and IP3 were conducted in the 1970s. These studies included thermal modeling of near-field effects using the Cornell University Mixing Zone Model (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology (MIT) dynamic network model (also called the far-field thermal model). For the purpose of modeling, near-field was defined as the region in the immediate vicinity of each station discharge where cooling water occupies a clearly distinguishable, three-dimensional temperature regime in the river that is not yet fully mixed; far-field was defined as the region farthest from the discharges where the plumes are no longer distinguishable from the river, but the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed sufficient by the utilities and their contractor and was designed and configured to account for time-variable hydraulic and meteorological conditions and heat sources of artificial origins. Model output included a prediction of temperature distribution for the Hudson River from the Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the permit applicants applied CORMIX modeling to develop a three-dimensional plume configuration of near-field thermal conditions that could be compared to applicable water quality criteria.

The former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September. These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

i. Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.

ii. Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each station, and concurrent operation of all three generating stations at maximum permitted capacity (CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX model runs were integrated with the riverwide temperature profiles developed by the MIT dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises above ambient) for various operating scenarios, the surface width of the plume, the depth of the plume, the percentage of surface width relative to the river width at a given location, and the percentage of cross-sectional area bounded by the 4°F (2°C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999). For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86°F (1.18 to 1.59°C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4°F (2°C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24°F (1.80°C) during June ebb tides to 4.63°F (2.57°C) during flood tides in August. Temperature increases exceeded 4°F (2°C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4°F (2°C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events.

Exceedences generally occurred under scenarios that the applicants indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding, CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

More recently, a triaxial thermal plume study was completed. Swanson et al. (2011 b) conducted thermal sampling and modeling of the cooling water discharge at Indian Point and reported that the extent and shape of the thermal plume varied greatly, primarily in response to tidal currents. For example, the plume (illustrated as a 4°F temperature increase or LH isotherm, Figure 5-6 in Swanson et al. 2011 b) generally followed the eastern shore of the Hudson River and extended northward from Indian Point during flood tide and southward from Indian Point during ebb tide. Depending on tides, the plume can be well-defined and reach a portion of the near-shore bottom or be largely confined to the surface.

Temperature measurements reported by Swanson et al. (2011 b) generally show that the warmest water in the thermal plume is close to the surface and plume temperatures tend to decrease with depth. Occasionally, the thermal plume extends deeply rather than across the surface. A cross-river survey conducted in front of Indian Point captured one such incident during spring tide on July 13, 2010 (Figure 3-28 in Swanson et al. 2011b). Across most of the river, water temperatures were close to 82°F (28°C), often with warmer temperatures near the surface and cooler temperatures near the bottom. The Indian Point thermal plume at that point was clearly defined and extended about 1000 ft (300 m) from shore. Surface water temperatures reached about 85°F (29°C). At 23-ft to about 25-ft (7-m to 8-m) depths, observed plume temperatures were 83° to 84°F (28° to 29°C). Maximum river depth along the measured transect is approximately 50 ft (15 m).

A temperature contour plot of a cross-river transect at Indian Point prepared in response to a NYSDEC review illustrates a similar condition on July 11, 2010 during slack before flood tide (Swanson et al. 2011a, Figure 1-10). Here the thermal plume is evident to about 2000 ft (600 m) from the eastern shore (the location of the Indian Point discharge) and extends to a depth of about 35 ft (11 m) along the eastern shore. Bottom temperatures above 82°F (28°C), were confined to about the first 250 ft (76 m) from shore. The river here is over 4500 ft (1400 m) wide. In that small area, bottom water temperatures might also exceed 30°C (86°F); elsewhere, bottom water temperatures were about 80°F (27°C). These conditions would not last long, however, as they would change with the tidal cycle. Further, any sturgeon in this location would be able to retreat to adjacent deeper and cooler water. Under no conditions did interpolated temperatures in Entergy's modeled results exceed the 28°C in the deep reaches of the river channel (Swanson 2011 a).

In response to the NYSDEC's review of the Indian Point thermal studies (Swanson et al. 2011 b), Mendelsohn et al. (2011) modeled the maximum area and width of the thermal plume (defined by the 4°F (2°C) ΔT isotherms) in the Hudson River. Mendelsohn, et al. reported that for four cross-river transects near IP2 and IP3, the maximum cross-river area of the plume would not exceed 12.3 percent and the maximum cross-river width of the plume would not exceed 28.6 percent of the river (Mendelsohn, et al.'s Table 3-1).

Thermal Tolerances – Shortnose sturgeon

Most organisms can acclimate (i.e. metabolically adjust) to temperatures above or below those to which they are normally subjected. Bull (1936) demonstrated, from a range of marine species, that fish could detect and respond to a temperature front of 0.03 to 0.07°C. Fish will therefore attempt to avoid stressful temperatures by actively seeking water at the preferred temperature. The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3°C (Dadswell et al. 1984) and as high as 34°C (Heidt and Gilbert 1978). Foraging is known to occur at temperatures greater than 7°C (Dadswell 1979). In the Altamaha River, temperatures of 28-30°C during summer months are correlated with movements to deep cool water refuges. Ziegewald et al. (2008a) conducted studies to determine critical and lethal thermal maxima for young-of-the-year (YOY) shortnose sturgeon acclimated to temperatures of 19.5 and 24.1°C. Lethal thermal maxima were 34.8°C (±0.1) and 36.1°C (±0.1) for fish acclimated to 19.5 and 24.1°C, respectively. The study also used thermal maximum data to estimate upper limits of safe temperature, final thermal preferences, and optimum growth temperatures for YOY shortnose sturgeon. Visual observations suggest that fish exhibited similar behaviors with increasing temperature regardless of acclimation temperature. As temperatures increased, fish activity appeared to increase; approximately 5–6°C prior to the lethal endpoint, fish began frantically swimming around the tank, presumably looking for an escape route. As fish began to lose equilibrium, their activity level decreased dramatically, and at about 0.3°C before the lethal endpoint, most fish were completely incapacitated. Estimated upper limits of safe temperature (ULST) ranged from 28.7 to 31.1°C and varied with acclimation temperature and measured endpoint. Upper limits of safe temperature (ULST) were determined by subtracting a safety factor of 5°C from the lethal and critical thermal maxima data. Final thermal preference and thermal growth optima were nearly identical for fish at each acclimation temperature and ranged from 26.2 to 28.3°C. Critical thermal maxima (the point at which fish lost equilibrium) ranged from 33.7 (±0.3) to 36.1°C (±0.2) and varied with acclimation temperature. Ziegwied et al. (2008b) used data from laboratory experiments to examine the individual and interactive effects of salinity, temperature, and fish weight on the survival of young-of-year shortnose sturgeon. Survival in freshwater declined as temperature increased, but temperature tolerance increased with body size. The authors conclude that temperatures above 29°C substantially reduce the probability of survival for young-of-year shortnose sturgeon. However, previous studies indicate that juvenile sturgeons achieve optimum growth at temperatures close to their upper thermal survival limits (Mayfield and Cech 2004; Allen et al. 2006; Ziegeweid et al. 2008a), suggesting that shortnose sturgeon may seek out a narrow temperature window to maximize somatic growth without substantially increasing maintenance metabolism. Ziegeweid (2006) examined thermal tolerances of young of the year shortnose sturgeon in the lab. The lowest temperatures at which mortality occurred ranged from 30.1 – 31.5C depending on fish size and test conditions. For shortnose sturgeon, dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Effect of Thermal Discharge on Shortnose Sturgeon

Lab studies indicate that thermal preferences and thermal growth optima for shortnose sturgeon range from 26.2 to 28.3C. This is consistent with field observations which correlate movements of shortnose sturgeon to thermal refuges when river temperatures are greater than 28C in the Altamaha River. Lab studies (see above; Ziegweid et al. 2008a and 2008b) indicate that thermal maxima for shortnose sturgeon are 33.7(±0.3) – 36.1(±0.1), depending on endpoint (loss of equilibrium or death) and acclimation temperature. Upper limits of safe temperature were calculated to be 28.7 – 31.1C. At temperatures 5-6C less than the lethal maximum, shortnose sturgeon are expected to begin demonstrating avoidance behavior and attempt to escape from heated waters; this behavior would be expected when the upper limits of safe temperature are exceeded.

NMFS first considers the potential for shortnose sturgeon to be exposed to temperatures which would most likely result in mortality (33.7°C (92.66°F) or greater). The maximum observed temperature of the thermal discharge is approximately 35°C. Modeling has demonstrated that the surface area of the river affected by the Indian Point plume where water temperatures would exceed 32.22C (90°F) would be limited to an area no greater than 75 acres. Information provided by Entergy and presented in the recent thermal model (Swanson et al. 2011) indicate that water temperatures at the river bottom will not exceed 32.2°C in waters more than 5 meters from the surface. Water depths in the area are approximately 18meters. Given this information, it is unlikely that shortnose sturgeon remaining near the bottom of the river would be exposed to water temperatures of 33.7°C. Temperatures at or above 33.7°C will occasionally be experienced at the surface of the river in areas closest to the discharge point. However, given that fish are known to avoid areas with unsuitable conditions and that shortnose sturgeon are likely to actively avoid heated areas, as evidenced by shortnose sturgeon known to move to deep cool water areas during the summer months in southern rivers, it is likely that shortnose sturgeon will avoid the area where temperatures are greater than tolerable. As such, it is extremely unlikely that any shortnose sturgeon would remain within the area where surface temperatures are elevated to 33.7°C and be exposed to potentially lethal temperatures. This risk is further reduced by the limited amount of time shortnose sturgeon spend near the surface, the small area where such high temperatures will be experienced and the gradient of warm temperatures extending from the outfall; shortnose sturgeon are likely to begin avoiding areas with temperatures greater than 28°C and are unlikely to remain within the heated surface waters to swim towards the outfall and be exposed to temperatures which could result in mortality. Below, NMFS considers what effect this avoidance behavior would have on individual shortnose sturgeon. Near the bottom where shortnose sturgeon most often occur, water temperatures are not likely to ever reach 33.7°C, creating no risk of exposure to temperatures likely to be lethal near the bottom of the river.

NMFS has also considered the potential for shortnose sturgeon to be exposed to water temperatures greater than 28°C. Some researchers suggest, based largely on observations of sturgeon behavior in southern rivers, that water temperatures of 28°C or greater can be stressful for sturgeon and that shortnose sturgeon are likely to actively avoid areas with these temperatures. This temperature (28°C) is close to both the final thermal preference and thermal growth optimum temperatures that Ziegewald et al. (2008) reported for juvenile shortnose sturgeon acclimated to 24.1 °C (75.4 °F), and thus is consistent with observations that optimum growth temperatures are often near the maximum temperatures fish can endure without experiencing physiological stress.

In the summer months (June – September) ambient river temperatures can be high enough that temperature increases as small as 1-4°C may cause water temperatures within the plume to be high enough to be avoided by shortnose sturgeon (greater than 28°C). When ambient river temperatures are at or above 28°C, the area where temperatures are raised by more than 1.5°C are expected to be limited to a surface area of up to 75 acres. Shortnose sturgeon exposure to the surface area where water temperature may be elevated above 28°C due to the influence of the thermal plume is limited by their normal behavior as benthic-oriented fish, which results in limited occurrence near the water surface. Any surfacing shortnose sturgeon are likely to avoid near surface waters with temperatures greater than 28°C. Reactions to this elevated temperature are expected to consist of swimming away from the plume by traveling deeper in the water column or swimming around the plume. As the area that would be avoided is at or near the surface, away from bottom waters where shortnose sturgeon spend the majority of time and complete all essential life functions that are carried out in the action area(foraging, migrating, overwintering, resting), and given the small area that may have temperatures elevated above 28°C it is extremely unlikely that these minor changes in behavior will preclude shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

Under no conditions did interpolated temperatures in Entergy's modeled results exceed 28°C (82°F) in the deep reaches of the river channel (Swanson 2011 a) where shortnose sturgeon are most likely to occur. Swanson also examined other sources of available bottom water temperature data for the Indian Point area. Based upon examination of the 1997 through 2010 long river survey water temperature data from the near-bottom stations near Indian Point, 28°C was exceeded for just 56 of 1,877 observations or 2.98% during this 14-year period (readings measured weekly from March through November). These already low incidences of observed near-bottom water temperatures above 28°C would be even lower when viewed in the context of an entire year instead of the nine months sampled due to the cold water period not sampled from December through February (i.e., 2.24% for the Indian Point region).

Given that shortnose sturgeon are known to actively seek out cooler waters when temperatures rise to 28°C, any shortnose sturgeon encountering bottom waters with temperatures above 28°C area are likely to avoid it. Reactions to this elevated temperature are expected to be limited to swimming away from the plume by swimming around it. Given the extremely small percentage of the estuary that may have temperatures elevated above 28°C and the limited spatial and temporal extent of any elevations of bottom water temperatures above 28°C, it is extremely unlikely that these minor changes in behavior will preclude shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

Water temperature and dissolved oxygen levels are related, with warmer water generally holding less dissolved oxygen. As such, NMFS has considered the potential for the discharge of heated effluent to affect dissolved oxygen in the action area. Entergy provided an assessment of dissolved oxygen conditions in the vicinity of the thermal plume and nearby downstream areas. Swanson examined dissolved oxygen concentrations observed among 14 recent years (1997 through 2010) of water quality samples taken 0.3 m (1 ft) above the river bottom weekly during the Utilities Fall Shoals surveys in the Indian Point region of the Hudson River from March through November of each year. Only 17 (0.91%) dissolved oxygen concentrations below 5 mg/l were observed in the Indian Point region during this 14-year period consisting of 1,877 readings, and the lowest dissolved oxygen concentration of 3.4 mg/l occurred just once, while the remaining 16 values were between 4.4 mg/l and 4.9 mg/l. Although I/FS survey water quality sampling did not occur in the Indian Point region during the winter period from December through February of each year due to river ice conditions, it is unlikely that dissolved oxygen concentrations below 5 mg/l would be observed then due to the high oxygen saturation of the cold water in the winter. The Hudson River region south of the Indian Point region had 501 dissolved oxygen concentrations below 5 mg/l (6.33% of 7,918 total observations) in the near bottom waters, seven times more frequently than the Indian Point region. Based on this information the discharge of heated effluent appears to have no discernible effect on dissolved oxygen levels in the area. As the thermal plume is not contributing to reductions in dissolved oxygen levels, it will not cause changes in dissolved oxygen levels that could affect any shortnose sturgeon.

Effect on Shortnose Sturgeon Prey

Shortnose sturgeon feed primarily on benthic invertebrates; these prey species are found on the bottom. As explained above, the IP thermal plume is largely a surface plume with elevated temperatures near the bottom limited to short duration and a geographic area limited to the area close to the discharge point. No analysis specific to effects of the thermal plume on the macroinvertebrate community has been conducted. However, given what is known about the plume (i.e., that it is largely a surface plume and has limited effects on water temperatures at or near the bottom) and the areas where shortnose sturgeon forage items are found (i.e., on the bottom), it is unlikely that potential shortnose sturgeon forage items would be exposed to the effects of the thermal plume. If the thermal plume is affecting benthic invertebrates, the most likely effect would be to limit their distribution to areas where bottom water temperatures are not affected by the thermal plume. Considering that shortnose sturgeon are also likely to be excluded from areas where the thermal plume influences bottom water temperatures and given that those areas are small, foraging shortnose sturgeon are not likely to be affected by any limits on the distribution of benthic invertebrates caused by the thermal plume's limited influence on bottom waters. Thus, based on this analysis, it appears that the prey of shortnose sturgeon, would be impacted insignificantly, if at all, by the thermal discharge from IP.

CUMULATIVE EFFECTS

Cumulative effects as defined in 50 CFR 402.02 to include the effects of future State, tribal, local or private actions that are reasonably certain to occur within the action area considered in the biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. Ongoing Federal actions are considered in the "Environmental Baseline" section above.

Sources of human-induced mortality, injury, and/or harassment of shortnose sturgeon in the action area that are reasonably certain to occur in the future include incidental takes in state-regulated fishing activities, pollution, global climate change, research activities and, coastal development. While the combination of these activities may affect shortnose sturgeon, preventing or slowing a species' recovery, the magnitude of these effects in the action area is currently unknown.

State Water Fisheries - Future recreational and commercial fishing activities in state waters may take shortnose sturgeon. In the past, it was estimated that up to 100 shortnose sturgeon were captured in shad fisheries in the Hudson River. In 2009, NY State closed the shad fishery indefinitely. That state action is considered to benefit for shortnose sturgeon. Should the shad fishery reopen, shortnose sturgeon would be exposed to the risk of interactions with this fishery. However, NMFS has no indication that reopening the fishery and any effects from it on shortnose sturgeon are reasonably certain to occur. Information on interactions with shortnose sturgeon for other fisheries operating in the action area is not available and it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Environmental Baseline section.

Pollution and Contaminants – Human activities in the action area causing pollution are reasonably certain to continue in the future, as are impacts from them on shortnose sturgeon. However, the level of impacts cannot be projected. Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival.

As discussed above, whether NYDEC will reverse its denial of a Section 401Water Quality Certification and issue a new SPDES permit is not reasonably certain to occur; therefore, the effects of any reversal and new SPDES permit are also not reasonably certain.

In the future, *global climate change* is expected to continue and may impact shortnose sturgeon and their habitat in the action area. However, as noted in the "Status of the Species" and "Environmental Baseline" sections above, given the likely rate of change associated with climate impacts (i.e., the century scale), it is unlikely that climate related impacts will have a significant effect on the status of shortnose sturgeon over the temporal scale of the proposed action (i.e., from September 2013 to September 2033 (IP2) and December 2015 through December 2035 (IP3)) or that in this time period, the abundance, distribution, or behavior of these species in the action area will change as a result of climate change related impacts. The greatest potential for climate change to impact NMFS assessment would be if ambient water temperatures increased enough such that the thermal plume caused a larger area of the Hudson River to have temperatures that were stressful or lethal to shortnose sturgeon. In the 2000s, the mean Hudson river water temperature, as measured at the Poughkeepsie Water Treatment Facility, was approximately 2°C higher than averages recorded in the 1960s (Pisces 2008). However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Hudson River generally. Assuming that the water temperatures in the river increased at the same rate over the next 40 years, one could anticipate a 1C increase over the proposed 20 year operating period. Given this small increase, it is not reasonably certain that over the proposed 20-year operating period that any water temperature changes would be significant enough to affect the conclusions reached by NMFS above.

INTEGRATION AND SYNTHESIS OF EFFECTS

NMFS has estimated that the proposed continued operation of IP2 and IP3 through the extended license period (September 2013 through September 2033 and December 2015 through December 2035, respectively) will result in the impingement of up to 104 shortnose sturgeon at IP2 and 58 shortnose sturgeon at IP3. As explained in the "Effects of the Action" section, all other effects to shortnose sturgeon, including to their prey and from the discharge of heat, will be insignificant or discountable.

In the discussion below, NMFS considers whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of shortnose sturgeon. The purpose of this analysis is to determine whether the proposed action would jeopardize the continued existence of shortnose sturgeon. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Below, for each of the listed species that may be affected by the proposed action, NMFS summarizes the status of the species and considers whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of that species.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

The Hudson River population of shortnose sturgeon is the largest in the United States. Historical estimates of the size of the population are not available as historic records of sturgeon in the river did not discriminate between Atlantic and shortnose sturgeon. Population estimates made by Dovel et al. (1992) based on studies from 1975-1980 indicated a population of 13,844 adults. Bain et al. (1998) studied shortnose sturgeon in the river from 1993-1997 and calculated an adult population size of 56,708 with a 95% confidence interval ranging from 50,862 to 64,072 adults. Bain determined that based on sampling effort and methodology his estimate is directly comparable to the population estimate made by Dovel et al. Bain concludes that the population of shortnose sturgeon in the Hudson River in the 1990s was 4 times larger than in the late 1970s. Bain states that as his estimate is directly comparable to the estimate made by Dovel, this increase is a "confident measure of the change in population size." Bain concludes that the Hudson River population is large, healthy and particular in habitat use and migratory behavior. Woodland and Secor (2007) conducted studies to determine the cause of the increase in population size. Woodland and Secor captured 554 shortnose sturgeon in the Hudson River and made age estimates of these fish. They then hindcast year class strengths and corrected for gear selectivity and cumulative mortality. The results of this study indicated that there was a period of high recruitment (31,000 – 52,000 yearlings) in the period 1986-1992 which was preceded and succeeded by 5 years of lower recruitment (6,000 – 17,500 yearlings/year). Woodland and Secor reports that there was a 10-fold recruitment variability (as measured by the number of yearlings produced) over the 20-year period from the late 1970s to late 1990s and that this pattern is expected in a species, such as shortnose sturgeon, with periodic life history characterized by delayed maturation, high fecundity and iteroparous spawning, as well as when there is variability in interannual hydrological conditions. Woodland and Secor examined environmental conditions throughout this 20-year period and determined that years in which water temperatures drop quickly in the fall and flow increases rapidly in the fall (particularly October), are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults.

The Hudson River population of shortnose sturgeon has exhibited tremendous growth in the 20-year period between the late 1970s and late 1990s. Woodland and Secor conclude that this a robust population with no gaps in age structure. Lower recruitment that followed the 1986-1992 period is coincident with record high abundance suggesting that the population may be reaching carrying capacity. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act."

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of populations, such as that in the Chesapeake Bay, add uncertainty to any determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is at best stable, with gains in populations such as the Hudson, Delaware and Kennebec offsetting the continued decline of southern river populations, and at worst declining. As described in the Status of the Species, Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the action area are affected by habitat alteration, bycatch in commercial and recreational fisheries, water quality and in-water construction activities. Despite these ongoing threats, numbers of shortnose sturgeon in the action area are considered stable, and this trend is expected to continue over the 20-year duration of the proposed action.

NMFS has estimated that the proposed continued operation of IP2 and IP3 through the extended license period (September 2013 through September 2033 and December 2015 through December 2035, respectively) will result in the impingement of up to 104 shortnose sturgeon at IP2 and 58 shortnose sturgeon at IP3, all of which may die as a result of their impingement. This number represents a very small percentage of the shortnose sturgeon population in the Hudson River, which is believed to be stable, and an even smaller percentage of the total population of shortnose sturgeon rangewide. The best available population estimates indicate that there are approximately 56,708 (95% CI=50,862 to 64,072) adult shortnose sturgeon in the Hudson River and an unknown number of juveniles (ERC 2006). While the death of up to 162 shortnose sturgeon over a 20-year period will reduce the number of shortnose sturgeon in the population compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population or its stable trend as this loss represents a very small percentage of the population (0.28%).

Reproductive potential of the Hudson population is not expected to be affected in any other way other than through a reduction in numbers of individuals. A reduction in the number of shortnose sturgeon in the Hudson River would have the effect of reducing the amount of potential reproduction in this system as the fish killed would have no potential for future reproduction. However, it is estimated that on average, approximately 1/3 of adult females spawn in a particular year and approximately ½ of males spawn in a particular year. Given that the best available estimates indicate that there are more than 56,000 adult shortnose sturgeon in the Hudson River, it is reasonable to expect that there are at least 20,000 adults spawning in a particular year. It is unlikely that the loss of 162 shortnose sturgeon over a 20-year period would affect the success of spawning in any year. Additionally, this small reduction in potential spawners is expected to result in a small reduction in the number of eggs laid or larvae produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individuals that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be very small and would not change the stable trend of this population. Additionally, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

The proposed action is not likely to reduce distribution because the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Hudson River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Additionally, as the number of shortnose sturgeon likely to be killed as a result of the proposed action is approximately 0.28% of the Hudson River population, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species can have an appreciable effect on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity (see status of the species section above), and there are thousands of shortnose sturgeon spawning each year.

Based on the information provided above, the death of up to 162 shortnose sturgeon over a 20-year period resulting from the proposed continued operation of IP2 and IP3 under renewed licenses for the period September 2013 through September 2033 (IP2) and December 2015 through December 2035 (IP3) will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) the population trend of shortnose sturgeon in the Hudson River is stable; (2) the death of up to 162 shortnose sturgeon represents an extremely small percentage of the number of shortnose sturgeon in the Hudson River and a even smaller percentage of the species as a whole; (3) the loss of these shortnose sturgeon is likely to have such a small effect on reproductive output of the Hudson River population of shortnose sturgeon or the species as a whole that the loss of these shortnose sturgeon will not change the status or trends of the Hudson River population or the species as a whole; (4) and, the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area (related to movements around the thermal plume) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival but might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild. Here, NMFS considers the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in a small reduction in the number of shortnose sturgeon in the Hudson River and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is likely to result in the mortality of up to 162 shortnose sturgeon; however, over the 20-year period, the loss of these individuals and what would have been their progeny is not expected to affect the persistence of the Hudson River population of shortnose sturgeon or the species as a whole. The loss of these individuals will not change the status or trend of the Hudson River population, which is stable at high numbers. As it will not affect the status or trend of this population, it will not affect the status or trend of the species as a whole. As the reduction in numbers and future reproduction is very small, this loss would not result in an appreciable reduction in the likelihood of improvement in the status of shortnose sturgeon throughout their range. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only a small percentage of the shortnose sturgeon in the Hudson River and an even smaller percentage of the species as a whole and these mortalities are not expected to result in the reduction of overall reproductive fitness for the species as a whole. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than 162 shortnose sturgeon over the 20-year period of the proposed renewed licenses is not likely to appreciably reduce the survival and recovery of this species.

CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the proposed action, interdependent and interrelated actions and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon. No critical habitat is designated in the action area; therefore, none will be affected by the proposed action.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by NRC so that they become binding conditions for the exemption in section 7(o)(2) to apply. NRC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NRC (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant, Entergy, to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the renewed license, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NRC or the applicant must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

Amount or Extent of Take

Pursuant to the terms of the proposed extended operating licenses, IP2 would continue to operate from September 2013 until September 2033 and IP3 will continue to operate from December 2015 until December 2035. The operation of IP2 and IP3 during the extended operating period will directly affect shortnose sturgeon due to impingement at intakes. These interactions constitute "capture" or "collect" in the definition of "take" and will cause injury and mortality to the affected individuals. Based on the distribution of shortnose sturgeon in the action area and information available on historic interactions between shortnose sturgeon and the IP facility, NMFS has estimated that the proposed action will result in the impingement of up to 104 shortnose sturgeon at IP2 and 58 shortnose sturgeon at IP3 during the 20-year extended operating period. All of these sturgeon are expected to die, immediately or later, as a result of interactions with the facility. As explained in the "Effects of the Action" section, effects of the facility on shortnose sturgeon also include effects on distribution due to the thermal plume as well as effects to prey items; however, NMFS does not anticipate or exempt any take of shortnose sturgeon due to effects to prey items or due to exposure to the thermal plume. This ITS exempts the following take:

A total of 104 shortnose sturgeon (dead or alive) impinged at Unit 2 during the period September 28, 2013 – September 28, 2033

A total of 58 shortnose sturgeon (dead or alive) impinged at Unit 3 during the period December 12, 2015 – December 12, 2035.

The Section 9 prohibitions against take apply to live individuals as well as to dead specimens and their parts. NMFS recognizes that shortnose sturgeon that have been killed prior to impingement at the IP facility may become impinged on the intakes at IP2 and IP3 and that some number of dead shortnose sturgeon taken at the facility may not necessarily have been killed by the operation of the facility itself. Due to the difficulty in determining the cause of death of shortnose sturgeon found dead at the intakes and the lack of past necropsy results that would allow NMFS to better assess the likely cause of death of impinged shortnose sturgeon, the aforementioned anticipated level of take includes shortnose sturgeon that may have been dead prior to impingement on the IP intakes. In the accompanying Opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to shortnose sturgeon.

Reasonable and Prudent Measures
In order to effectively monitor the effects of this action, it is necessary to monitor the intakes to document the amount of incidental take and to examine the shortnose sturgeon that are impinged at the facility. Monitoring provides information on the characteristics of the shortnose sturgeon encountered and may provide data which will help develop more effective measures to avoid future interactions with listed species. Any live sturgeon are to be released back into the river, away from the intakes and thermal plume. These RPMs and their implementing terms and conditions apply to both the license to be issued for the continued operation of IP Unit 2 and the license to be issued for the continued operation of IP Unit 3.

Reasonable and Prudent Measures
NMFS believes the following reasonable and prudent measures are necessary or appropriate for NRC and the applicant, Entergy, to minimize and monitor impacts of incidental take of endangered shortnose sturgeon:

1. A program to monitor the incidental take of shortnose sturgeon at the IP2 and IP3 intakes must be developed, approved by NMFS, and implemented.

3. All live shortnose sturgeon must be released back into the Hudson River at an appropriate location away from the intakes and thermal plume that minimizes the additional risk of death or injury.

4. Any dead shortnose sturgeon must be transferred to NMFS or an appropriately permitted research facility NMFS will identify so that a necropsy can be undertaken to attempt to determine the cause of death.

5. All shortnose sturgeon impingements associated with the Indian Point facility and any shortnose sturgeon sightings in the action area must be reported to NMFS.

Terms and Conditions
In order to be exempt from prohibitions of section 9 of the ESA, Entergy must comply with, and NRC must ensure through enforceable terms of the renewed license that Entergy does comply with, the following terms and conditions of the Incidental Take Statement, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned. (ESA Section 7(o)(2).) Due to the

difficulty in visually distinguishing shortnose sturgeon from other sturgeon, the terms and conditions below refer to "shortnose sturgeon or fish that might be shortnose sturgeon."

1. To implement RPM #1, Entergy must implement throughout the term of the renewed license an endangered species monitoring plan that has been approved by NMFS and that contains the following components: (a) the intake trash bars must be monitored with a method and on a schedule that ensures detection and timely release of any shortnose sturgeon or fish that might be shortnose sturgeon impinged on the trash bars; (b) the Ristroph screens must be monitored with a method and on a schedule that ensures detection and timely release of any shortnose sturgeon or fish that might be shortnose sturgeon that pass through the trash bars and are impinged on the screens.

2. To implement RPM #2, Entergy must ensure that any live shortnose sturgeon or fish that might be shortnose sturgeon are returned to the river away from the intakes and the thermal plume, following complete documentation of the event.

3. 6.To implement RPM #3, Entergy must ensure that any dead specimens or body parts of shortnose sturgeon or fish that might be sturgeon are photographed, measured, and preserved (refrigerate or freeze) and discuss disposal procedures with NMFS. NMFS may request that the specimen be transferred to NMFS or to an appropriately permitted researcher so that a necropsy may be conducted. The form included as Appendix I must be completed and submitted to NMFS as noted above.

4. To implement RPM #4, if any live or dead shortnose sturgeon or fish that might be shortnose sturgeon are taken at IP2 or IP3, Entergy must notify the NMFS Endangered Species Coordinator at 978-281-9208 immediately. An incident report (Appendix I) must also be completed by plant personnel and sent to the NMFS Section 7 Coordinator via FAX (978-281-9394) within 24 hours of the take. Every shortnose sturgeon, or fish that might be a shortnose sturgeon, must be photographed. Information in Appendix II will assist in identification of a shortnose sturgeon or fish that might be a shortnose sturgeon.

5. To implement RPM #2, Entergy must notify NMFS when the facility reaches 50% of the incidental take level for shortnose sturgeon. At that time, NMFS will determine if additional measures are necessary or appropriate to minimize impingement at the intake structures or if additional monitoring is necessary.

6. To implement RPM #4, Entergy must submit an annual report of incidental takes to NMFS by January 1 of each year. The report must include, as detailed in this Incidental Take Statement, any necropsy reports that were provided to Entergy, incidental take reports, photographs , a record of all sightings of shortnose sturgeon, or fish that might be a shortnose sturgeon, in the vicinity of Indian Point, and a record of when inspections of the intake trash bars were conducted for the 24 hours prior to the take. The annual report must also identify any potential measures to reduce shortnose sturgeon impingement, injury, and mortality at the intake structures. At the time the report is submitted, NMFS

will supply NRC and Entergy with any information on changes to reporting requirements (i.e., staff changes, phone or fax numbers, e-mail addresses) for the coming year.

7. To implement RPM #4, Entergy must ensure that fin clips are taken (according to the procedure outlined in Appendix III) of any dead shortnose sturgeon or dead fish that might be shortnose sturgeon, and that the fin clips are sent to NMFS for genetic analysis .

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will ensure that Entergy monitors the intakes in a way that allows for the detection of any impinged shortnose sturgeon and implements measures to reduce the potential of mortality for any shortnose sturgeon impinged at Indian Point, to report all interactions to NMFS and to provide information on the likely cause of death of any shortnose sturgeon impinged at the facility. The discussion below explains why each of these RPMs and Terms and Conditions are necessary or appropriate to minimize or monitor the level of incidental take associated with the proposed action. The RPMs and terms and conditionsinvolve only a minor change to the proposed action.

RPM #1 and Term and Condition #1 arare necessary and appropriate because they are specifically designed to ensure that all appropriate measures are carried out to monitor the incidental take of shortnose sturgeon at Indian Point. An effective monitoring plan is essential to allow NRC and Entergy to fulfill the requirement to monitor the actual level of incidental take associated with the operation of Indian Point and to allow NMFS and NRC to determine if the level of incidental take is ever exceeded. These requirements are also essential for determining whether the death was related to the operation of the facility. These conditions ensure that the potential for detection of shortnose sturgeon at the intakes is maximized and that any shortnose sturgeon removed from the water are done so in a manner that minimizes the potential for further injury.

RPM#2 and Term and Condition #2 are necessary and appropriate to ensure that any shortnose sturgeon that survive impingement is given the maximum probability of remaining alive and not suffering additional injury or subsequent mortality through inappropriate handling or release near the intakes.

RPM #3 and Terms and Conditions #3 are necessary and appropriate to ensure the proper handling and documentation of any shortnose sturgeon removed from the intakes that are dead or die while in Entergy custody. This is essential for monitoring the level of incidental take associated with the proposed action and in determining whether the death was related to the operation of the facility.

RPM#4 and Term and Condition #4-7 are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as the prompt reporting of these interactions to NMFS.

CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. As such, NMFS recommends that the NRC consider the following Conservation Recommendations:

1. The NRC should support tissue analysis of dead shortnose sturgeon removed from the Indian Point intakes to determine contaminant loads.

2. The NRC should support in-water assessments, abundance, and distribution surveys for shortnose sturgeon in the Hudson River and Haverstraw Bay specifically.

REINITIATION OF CONSULTATION

This concludes formal consultation on the continued operation of IP2 and IP3 for an additional 20 years pursuant to a license proposed for issuance by NRC. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

LITERATURE CITED

Allen PJ, Nicholl M, Cole S, Vlazny A, Cech JJ Jr. 2006. Growth of larval to juvenile green sturgeon in elevated temperature regimes. Trans Am Fish Soc 135:89–96

ASA (Analysis and Communication). 2008. 2006 year class report for the Hudson River Estuary Program prepared for Dynegy Roseton LLC, on behalf of Dynegy Roseton LLC Entergy Nuclear Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, and Mirant Bowline LLC. Washingtonville NY.

Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M., K. Arend, N. Haley, S. Hayes, J. Knight, S. Nack, D. Peterson, and M. Walsh. 1998a. Sturgeon of the Hudson River: Final Report on 1993-1996 Research. Prepared for The Hudson River Foundation by the Department of Natural Resources, Cornell University, Ithaca, New York.

Bain, Mark B., D.L. Peterson, K. K. Arend. 1998b. Population status of shortnose sturgeon in the Hudson River: Final Report. Prepared for Habitat and Protected Resources Division National Marine Fisheries Service by New York Cooperative Fish and Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY.

Bain, Mark B., N. Haley, D. L. Peterson, K. K. Arend, K. E. Mills, P. J. Sullivan. 2000. Annual meeting of American fisheries Society. EPRI-AFS Symposium: Biology, Management and Protection of Sturgeon. St. Louis, MO. 23-24 August 2000.

Bain, Mark B., N. Haley, D. L. Peterson, K. K Arend, K. E. Mills, P. J. Sulivan. 2007. Recovery of a US Endangered Fish. PLoS ONE 2(1): e168. doi:10.1371/journal.pone.0000168

Bath, D.W., J.M. O'Conner, J.B. Albert and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrinchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981:711-717.

Beamesderfer, Raymond C.P. and Ruth A. Farr. 1997. Alternatives for the protection and restoration of sturgeons and their habitat. Environmental Biology of Fishes 48: 407-417.

Berlin, W.H., R.J. Hesselberg, and M.J. Mac. 1981. Chlorinated hydrocarbons as a factor in the reproduction and survival of lake trout (Salvelinus namaycush) in Lake Michigan. Technical Paper 105 of the U.S. Fish and Wildlife Service, 42 pages.

Buckley, J., and B. Kynard. 1981. Spawning and rearing of shortnose sturgeon from the Connecticut River. Progressive Fish Culturist 43:74-76.

Buckley, J. and B. Kynard. 1985. Habitat use and behavior of pre-spawing and spawning shortnose sturgeon, *Acipenser brevirostrum*, in the Connecticut River. North American Sturgeons: 111-117.

Carlson, D.M., and K.W. Simpson. 1987. Gut contents of juvenile shortnose sturgeon in the upper Hudson estuary. Copeia 1987:796-802

CHGE. Central Hudson Gas and Electric Corp., Consolidated Edison Company of New York, New York Power Authority, and Southern Energy New York. 1999. Draft environmental impact statement for State pollution discharge elimination system permits for Bowline Point1&2, Indian Point 1&2, and Roseton 1&2 Steam electric generating stations.

Collins, M. R., S. G. Rogers, and T. I. J. Smith. 1996. Bycatch of sturgeons along the Southern Atlantic Coast of the USA. North American Journal of Fisheries Management 16: 24-29.

Dadswell, M.J. 1979. Biology and population characteristics of the shortnose sturgeon, Acipenser brevirostrum LeSueur 1818 (Osteichthyes: Acipenseridae), in the Saint John River estuary, New Brunswick, Canada. Canadian Journal of Zoology 57:2186-2210.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* Lesueur 1818. NOAA Technical Report, NMFS 14, National Marine Fisheries Service. October 1984 45 pp.

Dovel, W.J. 1978. The Biology and management of shortnose and Atlantic sturgeons of the Hudson River. Performance report for the period April 1, to September 30, 1978. Submitted to N.Y. State Department of Environmental Conservation.

Dovel, W.J. 1979. Biology and management of shortnose and Atlantic sturgeon of the Hudson River. New York State Department of Environmental Conservation, AFS9-R, Albany.

Dovel, W.L. 1981. The Endangered shortnose sturgeon of the Hudson Estuary: Its life history and vulnerability to the activities of man. The Oceanic Society. FERC Contract No. DE-AC 39-79 RC-10074.

Dovel, W.L., A.W. Pekovitch, and T.J. Berggren. 1992. Biology of the shortnose sturgeon (*Acipenser brevirostrum* Lesueur 1818) in the Hudson River estuary, New York. Pages 187-216 in C.L. Smith (editor). Estuarine research in the 1980s. State University of New York Press, Albany, New York.

Dwyer, F. James, Douglas K. Hardesty, Christopher G. Ingersoll, James L. Kunz, and David W. Whites. 2000. Assessing contaminant sensitivity of American shad, Atlantic sturgeon, and shortnose sturgeon. Final Report. U.S. Geological Survey. Columbia Environmental Research Center, 4200 New Have Road, Columbia, Missouri.

Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Indian Point, Units 2 & 3, License Renewal Application." April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to "Indian Point, Units 2 & 3, License Renewal Application".) April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from Fred Dacimo, Indian Point Energy Center Site Vice President, to the U.S. NRC regarding Indian Point Nuclear Generating Units Nos. 2 and 3. Docket Nos. 50-247, 50-286. May 3, 2007.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2002. Contaminant analysis of tissues from two shortnose sturgeon (Acipenser brevirostrum) collected in the Delaware River. Prepared for National Marine Fisheries Service. 16 pp. + appendices.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2007. Preliminary acoustic tracking study of juvenile shortnose sturgeon and Atlantic sturgeon in the Delaware River. May 2006 through March 2007. Prepared for NOAA Fisheries. 9 pp.

Eyler, Sheila M., Jorgen E. Skjeveland, Michael F. Mangold, and Stuart A. Welsh. 2000. Distribution of Sturgeons in Candidate Open Water Dredged Material Placement Sites in the Potomac River (1998-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 26 pp.

Fernandes, S.J. 2008. Population demography, distribution, and movement patterns of Atlantic and shortnose sturgeons in the Penobscot River estuary, Maine. University of Maine. Masters thesis. 88 pp.

Flournoy, P.H., S.G. Rogers, and P.S. Crawford. 1992. Restoration of shortnose sturgeon in the Altamaha River, Georgia. Final Report to the U.S. Fish and Wildlife Service, Atlanta, Georgia.

Geoghegan, P., M.T. Mattson and R.G Keppel. 1992. Distribution of shortnose sturgeon in the Hudson River, 1984-1988. IN Estuarine Research in the 1980s, C. Lavett Smith, Editor. Hudson River Environmental Society, Seventh symposium on Hudson River ecology. State University of New York Press, Albany NY, USA.

Giesy, J.P., J. Newsted, and D.L. Garling. 1986. Relationships between chlorinated hydrocarbon concentrations and rearing mortality of chinook salmon (Oncorhynchus tshawytscha) eggs from Lake Michigan. Journal of Great Lakes Research 12(1):82-98.

Gilbert, C.R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82, 28 pages.

Grunwald, C., J. Stabile, J.R. Waldman, R. Gross, and I. Wirgin. 2002. Population genetics of shortnose *sturgeon (Acipenser brevirostrum*) based on mitochondrial DNA control region sequences. Molecular Ecology 11: 000-000.

Hansen, P.D. 1985. Chlorinated hydrocarbons and hatching success in Baltic herring spring spawners. Marine Environmental Research 15:59-76.

Haley, N. 1996. Juvenile sturgeon use in the Hudson River Estuary. Master's thesis. University of Massachusetts, Amhearst, MA, USA.

Hall, W.J., T.I.J. Smith, and S.D. Lamprecht. 1991. Movements and habitats of shortnose sturgeon Acipenser brevirostrum in the Savannah River. Copeia (3):695-702.

Hastings, R.W. 1983. A study of the shortnose sturgeon (*Acipenser brevirostrum*) population in the upper tidal Delaware River: Assessment of impacts of maintenance dredging. Final Report to the U.S. Army Corps of Engineers, Philadelphia, Pennsylvania. 129 pp.

Heidt, A.R., and R.J. Gilbert. 1978. The shortnose sturgeon in the Altamaha River drainage, Georgia. Pages 54-60 in R.R. Odum and L. Landers, editors. Proceedings of the rare and endangered wildlife symposium. Georgia Department of Natural Resources, Game and Fish Division, Technical Bulletin WL 4, Athens, Georgia.

Holland, B.F., Jr. and G.F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources, Division of Commercial and Sports Fisheries, Morehead City. Special Scientific Report 24:1-132.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43: 617-627.IPCC (Intergovernmental Panel on Climate Change) 2007. Fourth Assessment Report. Valencia, Spain.

Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1993. Tolerance of shortnose sturgeon, *Acipenser brevirostrum*, juveniles to different salinity and dissolved oxygen concentrations. Proceedings of the Southeast Association of Fish and Wildlife Agencies, Atlanta, Georgia.

Kieffer, M.C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 1221: 1088-1103.

Kieffer, M., and B. Kynard. 1996. Spawning of shortnose sturgeon in the Merrimack River. Transactions of the American Fisheries Society 125:179-186.

Kieffer and Kynard in review [book to be published by AFS]. Kieffer, M. C., and B. Kynard. In review. Pre-spawning and non-spawning spring migrations, spawning, and effects of hydroelectric dam operation and river regulation on spawning of Connecticut River shortnose sturgeon.

Kocan, R.M., M.B. Matta, and S. Salazar. 1993. A laboratory evaluation of Connecticut River coal tar toxicity to shortnose sturgeon (*Acipenser brevirostrum)* embryos and larvae. Final Report to the National Oceanic and Atmospheric Administration, Seattle, Washington.

Kynard, B. 1996. Twenty-one years of passing shortnose sturgeon in fish lifts on the Connecticut River: what has been learned? Draft report by National Biological Service, Conte Anadromous Fish Research Center, Turners Falls, MA. 19 pp.

Kynard, B. 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon, Acipenser brevirostrum. Environmental Biology of Fishes 48:319–334.

Longwell, A.C., S. Chang, A. Hebert, J. Hughes and D. Perry. 1992. Pollution and developmental abnormalities of Atlantic fishes. Environmental Biology of Fishes 35:1-21.

Mac, M.J., and C.C. Edsall. 1991. Environmental contaminants and the reproductive success of lake trout in the Great Lakes: An epidemiological approach. Journal of Toxicology and Environmental Health 33:375-394.

Mayfield RB, Cech JJ Jr. 2004. Temperature effects on green sturgeon bioenergetics. Trans Am Fish Soc 133:961–970

Morgan, R.P., V.J. Rasin and L.A. Noe. 1973. Effects of Suspended Sediments on the Development of Eggs and Larvae of Striped Bass and White Perch. Natural resources Institute, Chesapeake Biological Laboratory, U of Maryland, Center for Environmental and Estuarine Studies. 20 pp.

Moser, M.L. and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234.

NAST (National Assessment Synthesis Team). 2008. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000 http://www.usgcrp.gov/usgcrp/Library/nationalassessment/1IntroA.pdf

National Marine Fisheries Service. 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.

NMFS, 1996b. Status Review of shortnose sturgeon in the Androscoggin and Kennebec Rivers. Northeast Regional Office, National Marine Fisheries Service, unpublished report. 26 pp.

NOAA. 1979. Testimony of Dr. Dadswell. May 14, 1979. Docket C/II-WP-77-01.

NRC 2010. Draft FSEIS – Indian Point

NRC 2009. Biological Assessment to NMFS for Indian Point relicensing.

NRC 2010b. Revised Biological Assessment to NMFS for Indian Point relicensing. December 2010.

NRC 2011. Supplement to Biological Assessment to NMFS for Indian Point relicensing. NYHS (New York Historical Society as cited by Dovel as Mitchell. S. 1811). 1809. Volume1. Collections of the New-York Historical Society for the year 1809.

NYDEC. 1982. State Pollution Discharge Elimination System Final Permit for Indian Point Nuclear Generating Station.

NYSDEC (New York State Department of Environmental Conservation). 2003. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2 Bowline 1 and 2 and IP2 and IP3 2 and 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties" (Hudson River Power Plants FEIS). June 25, 2003.

NYDEC. 2010. Letter from W. Adriance to D. Grey, Entergy. Denial of 401 WQC. April 2, 2010.

Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (Acipenser oxyrinchus and A. brevirostrum) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.

O'Herron, J.C., K.W. Able, and R.W. Hastings. 1993. Movements of shortnose sturgeon (*Acipenser brevirostrum)* in the Delaware River. Estuaries 16:235-240.

Parker E. 2007. Ontogeny and life history of shortnose sturgeon (*Acipenser brevirostrum* lesueur 1818): effects of latitudinal variation and water temperature. Ph.D. Dissertation. University of Massachusetts, Amherst. 62 pp.

Pekovitch, A.W. 1979. Distribution and some life history aspects of shortnose sturgeon (*Acipenser brevirostrum)* in the upper Hudson River Estuary. Hazleton Environmental Sciences Corporation. 67 pp.

Rogers, S. G., and W. Weber. 1994. Occurrence of shortnose sturgeon (Acipenser brevirostrum) in the Ogeechee-Canoochee river system, Georgia during the summer of 1993. Final Report of the United States Army to the Nature Conservancy of Georgia.

Rogers, S.G., and W. Weber. 1995a. Movements of shortnose sturgeon in the Altamaha River system, Georgia. Contributions Series #57. Coastal Resources Division, Georgia Department of Natural Resources, Brunswick, Georgia.

Rogers, S.G., and W. Weber. 1995b. Status and restoration of Atlantic and shortnose sturgeons in Georgia. Final Report to the National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.

Ruelle, R., and K.D. Keenlyne. 1993. Contaminants in Missouri River pallid sturgeon. Bull. Environ. Contam. Toxicol. 50: 898-906.

Ruelle, R. and C. Henry. 1994. Life history observations and contaminant evaluation of pallid sturgeon. Final Report U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, South Dakota Field Office, 420 South Garfield Avenue, Suite 400, Pierre, South Dakota 57501-5408.

Sherk, J.A. J.M. O'Connor and D.A. Neumann. 1975. Effects of suspended and deposited sediments on estuarine environments. *In*: Estuarine Research Vol. II. Geology and Engineering. L.E. Cronin (editor). New York: Academic Press, Inc.

Skjeveland, Jorgen E., Stuart A. Welsh, Michael F. Mangold, Sheila M. Eyler, and Seaberry Nachbar. 2000. A Report of Investigations and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake bay (1996-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 44 pp.

Smith, Hugh M. and Barton A. Bean. 1899. List of fishes known to inhabit the waters of the District of Columbia and vicinity. Prepared for the United States Fish Commission. Washington Government Printing Office, Washington, D.C.

Snyder, D.E. 1988. Description and identification of shortnose and Atlantic sturgeon larvae. American Fisheries Society Symposium 5:7-30.

Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. U.S. Fish and Wildlife Service, Charles City, Virginia.

Squiers, T., L. Flagg, and M. Smith. 1982. American shad enhancement and status of sturgeon stocks in selected Maine waters. Completion report, Project AFC-20.

Squiers, T. And M. Robillard. 1997. Preliminary report on the location of overwintering sites for shortnose sturgeon in the estuarial complex of the Kennebec River during the winter of 1996/1997. Unpublished report, submitted to the Maine Department of Transportation.

Swanson, C., D. Crowley, Y. Kim, N. Cohn, and D. Mendelsohn. 2011a. Part 2 of Response to the NYSDEC Staff Review of the 2010 Field Program and Modeling Analyis of the Cooling Water Discharge from the Indian Point Energy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. ML 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Swanson, C., D. Mendelsohn, N. Cohn, D. Crowley, Y. Kim, L Decker, and L Miller. 2011 b. Final Report: 2010 Field Program and Modeling Analysis of the Cooling Water Discharge from the Indian Point Entergy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. **ML** 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Taubert, B.D. 1980b. Biology of shortnose sturgeon (Acipenser brevirostrum) in the Holyoke Pool, Connecticut River, Massachusetts. Ph.D. Thesis, University of Massachusetts, Amherst, 136 p.

Taubert, B.D., and M.J. Dadswell. 1980. Description of some larval shortnose sturgeon (Acipenser brevirostrum) from the Holyoke Pool, Connecticut River, Massachusetts, USA, and the Saint John River, New Brunswick, Canada. Canadian Journal of Zoology 58:1125-1128.

Uhler, P.R. and O. Lugger. 1876. List of fishes of Maryland. Rept. Comm. Fish. MD. 1876: 67-176.

USDOI (United States Department of Interior). 1973. Threatened wildlife of the United States. Shortnose sturgeon. Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, Washington, D.C. Resource Publication 114 (Revised Resource Publication 34).

Varanasi, U. 1992. Chemical contaminants and their effects on living marine resources. pp. 59- 71. in: R. H. Stroud (ed.) Stemming the Tide of Coastqal Fish Habitat Loss. Proceedings of the Symposium on Conservation of Fish Habitat, Baltimore, Maryland. Marine Recreational Fisheries Number 14. National Coalition for Marine Conservation, Inc., Savannah Georgia.

Vinyard, L. and W.J. O'Brien. 1976. Effects of light and turbidity on the reactive distance of bluegill (*Lepomis macrochirus*) J. Fish. Res. Board Can. 33: 2845-2849.

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidea. Pages 24-60 in Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(Part III). xxi + 630 pp.

Von Westernhagen, H., H. Rosenthal, V. Dethlefsen, W. Ernst, U. Harms, and P.D. Hansen. 1981. Bioaccumulating substances and reproductive success in Baltic flounder Platichthys flesus. Aquatic Toxicology 1:85-99.

Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L. and J. Waldman. 2005. Range- wide population structure of shortnose sturgeon Acipenser brevirostrum based on sequence analysis of mitochondrial DNA control region. Estuaries 28:406-21.

Waldman JR, Grunwald C, Stabile J, Wirgin I. 2002. Impacts of life history and biogeography on genetic stock structure in Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, Gulf sturgeon *A. oxyrinchus desotoi*, and shortnose sturgeon, *A.brevirostrum.* J Appl Ichthyol 18:509-518

Walsh, M.G., M.B. Bain, T. Squires, J.R. Walman, and Isaac Wirgin. 2001. Morphological and genetic variation among shortnose sturgeon Acipenser brevirostrum from adjacent and distant rivers. Estuaries Vol. 24, No. 1, p. 41-48. February 2001.

Waters, Thomas F. 1995. Sediment in Streams. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, MD. Pages 95-96.

Weber, W. 1996. Population size and habitat use of shortnose sturgeon, Acipenser brevirostrum, in the Ogeechee River sytem, Georgia. Masters Thesis, University of Georgia, Athens, Georgia.

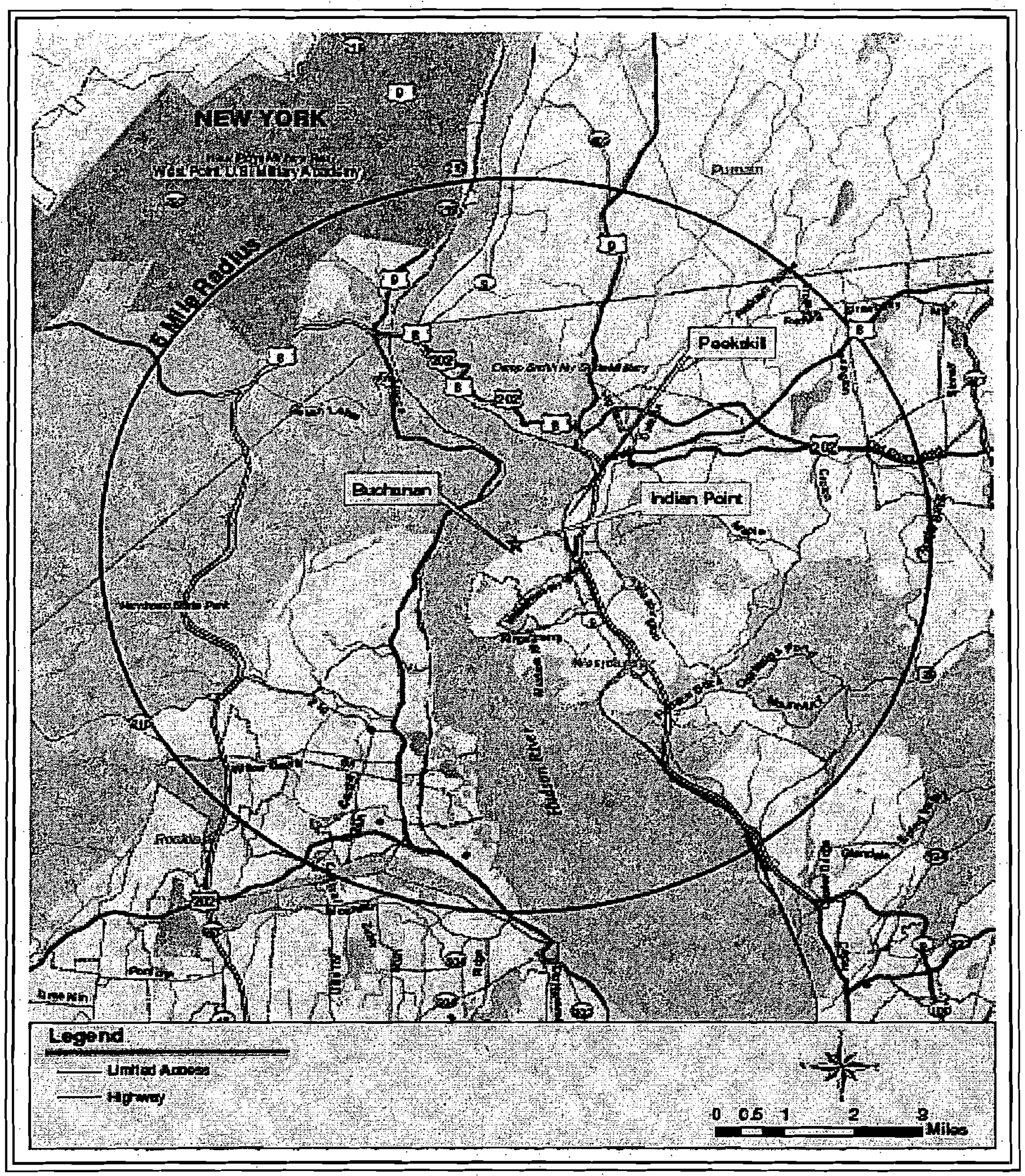
Welsh, Stuart A., Michael F. Mangold, Jorgen E. Skjeveland, and Albert J. Spells. 2002. Distribution and Movement of Shortnose Sturgeon (*Acipenser brevirostrum*) in the Chesapeake Bay. Estuaries Vol. 25 No. 1: 101-104.

Wilber, Dara H. and Douglas C. Clarke. 2001. Biological Effects of Suspended Sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Woodland, R. J. 2005. Age, growth, and recruitment of Hudson River shortnose sturgeon (Acipenser brevirostrum). Master's thesis. University of Maryland, College Park.

Woodland, R.J. and D. H. Secor. 2007. Year-class strength and recovery of endangered shortnose sturgeon in the Hudson River, New York. Transaction of the American Fisheries Society 136:72-81.
Management 21:855-875.

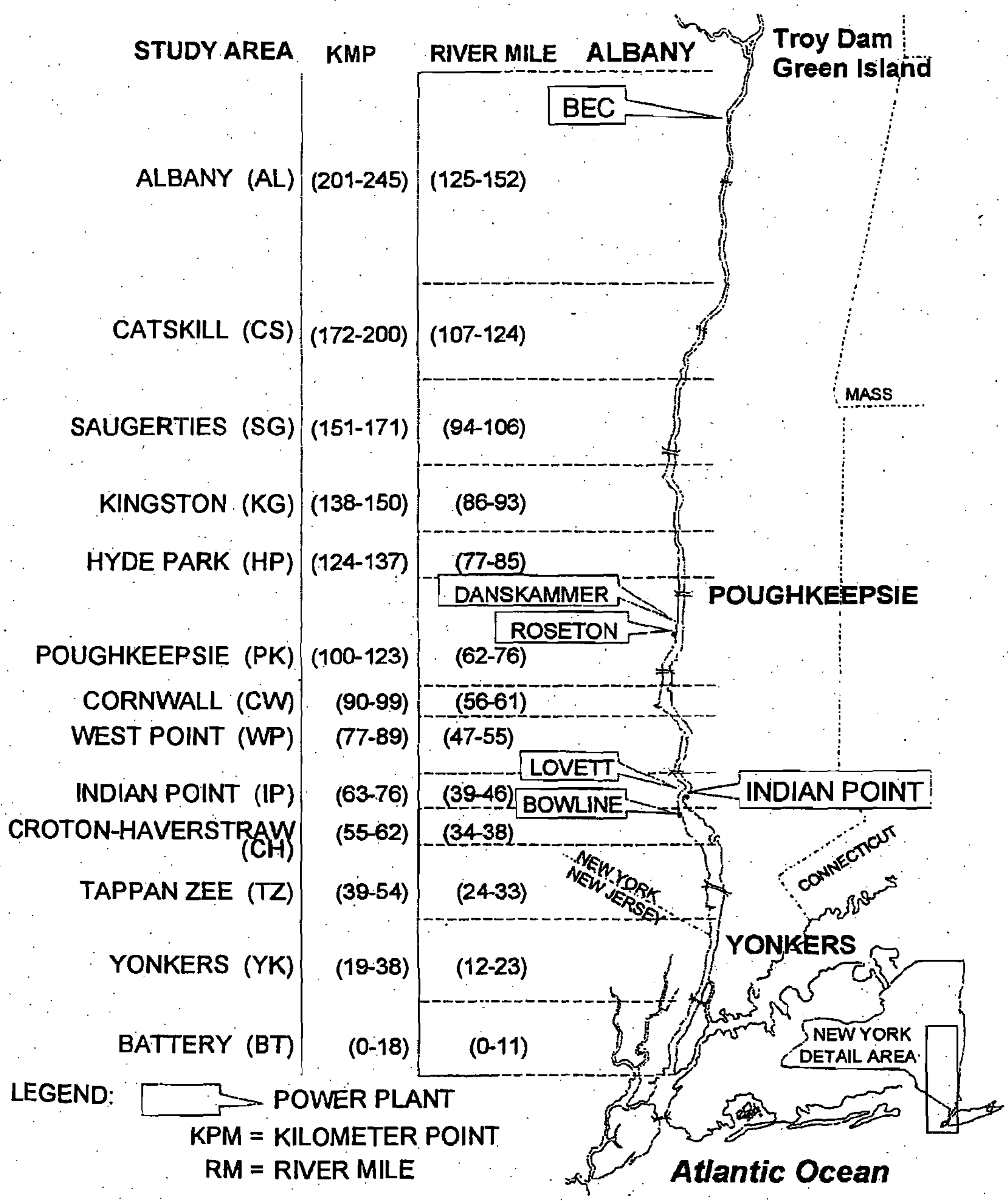
Ziegeweid, J.R., C.A. Jennings, and D.L. Peterson. 2008a. Thermal maxima for juvenile shortnose sturgeon acclimated to different temperatures. Environmental Biology of Fish 3: 299-307.

Ziegeweid, J.R., C.A. Jennings, D.L. Peterson and M.C. Black. 2008b. Effects of salinity, temperature, and weight on the survival of young-of-year shortnose sturgeon. Transactions of the American Fisheries Society 137:1490-1499.



Source: Entergy 2007a

Figure | '. Location of IP2 and IP3, 6-mi (10-km) radius



Source: Abood et al. 2006

Figure 2 Hudson study area and river segments

Appendix I
Incident Report Shortnose Sturgeon Take – Indian Point

Photographs should be taken and the following information should be collected from all sturgeon (alive and dead) found in association with the Indian Point intakes. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name:____
Reporter's full name:____

Species Identification (Key attached):_________________________________

Site of Impingement (Unit 2 or 3, CWS or DWS, Bay #, etc.):_________________________

Date animal observed:______________ Time animal observed: _________________
Date animal collected:______________ Time animal collected:_________________

Environmental conditions at time of observation (i.e., tidal stage, weather):
____
____

Date and time of last inspection of intakes:_______________________________
Water temperature (°C) at site and time of observation:______________________
Number of pumps operating at time of observation:____________________________
Average percent of power generating capacity achieved per unit at time of observation:________
Average percent of power generating capacity achieved per unit over the 48 hours previous to observation:____

Sturgeon Information:
Species ______________________________

Fork length (or total length) ____________________ Weight ____________________

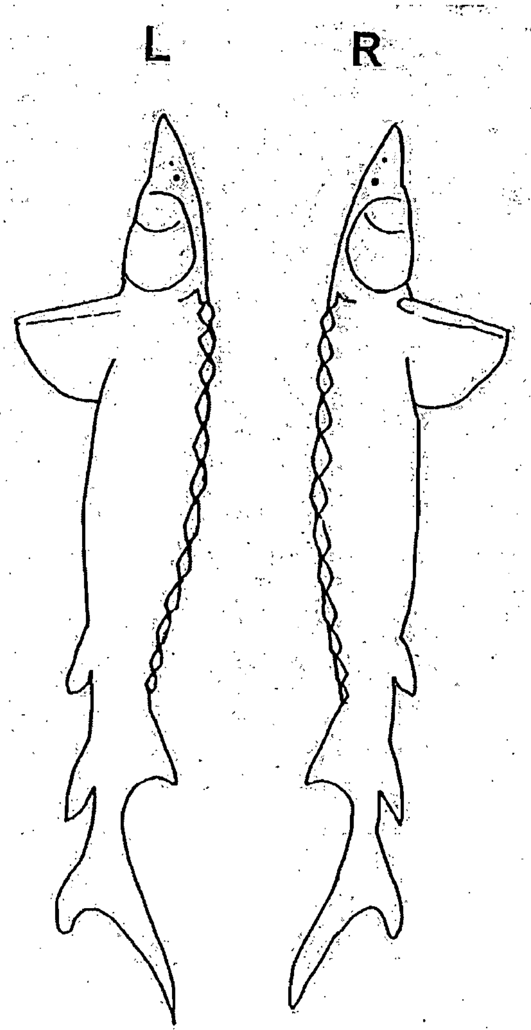
Condition of specimen/description of animal
____
____
____
____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish tagged: YES / NO *Please record all tag numbers.* Tag # _______________

Photograph attached: YES / NO
(please label *species, date, geographic site* and *vessel name* on back of photograph)

Appendix I, continued

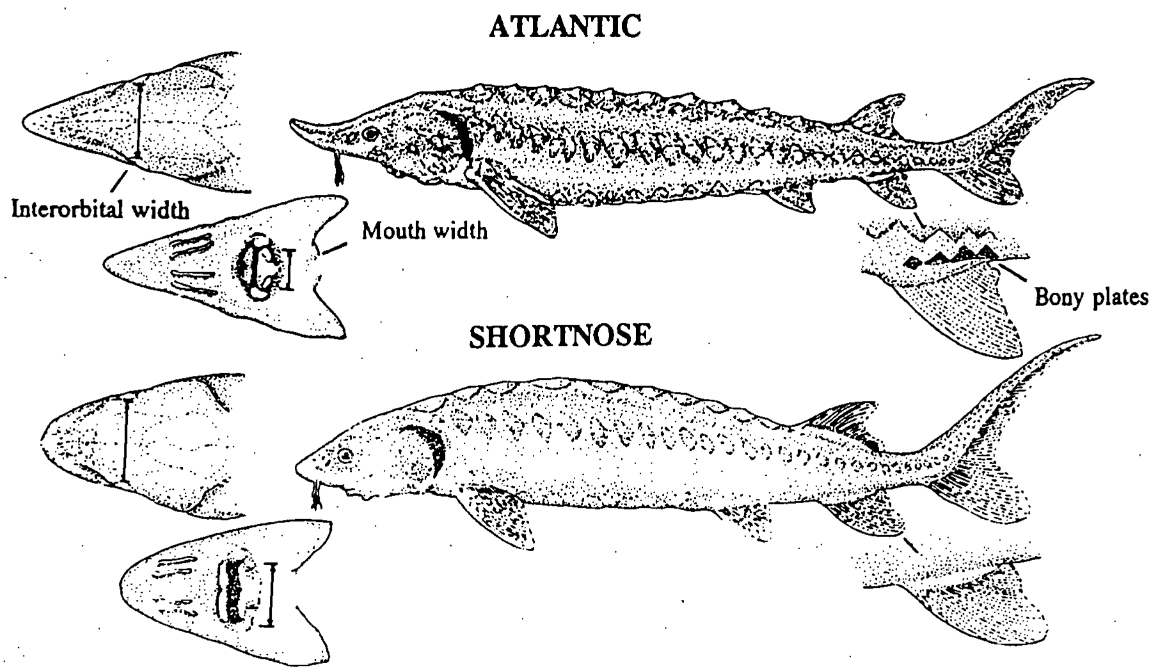
Draw wounds, abnormalities, tag locations on diagram and briefly describe below



Description of fish condition:

Appendix II

Identification Key for Sturgeon Found in Northeast U.S. Waters



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

Characteristic	Atlantic Sturgeon, *Acipenser oxyrinchus*	Shortnose Sturgeon, *Acipenser brevirostrum*
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004

APPENDIX III

Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

1. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

Sending of Sample

1. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547

   a. Prior to sending the sample, contact Russ Bohl at NMFS Northeast Regional Office (978-282-8493) to report that a sample is being sent and to discuss proper shipping procedures.

Riverkeeper Amended Contention RK-EC-8A:

Attachment 2

RIVERKEEPER.
NY's clean water advocate

September 15, 2011

VIA U.S. MAIL AND ELECTRONIC MAIL

Patricia A. Kurkul
Regional Administrator
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
patricia.kurkul@noaa.gov

Julie Crocker
Fisheries Biologist
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
julie.crocker@noaa.gov

Julie Williams
Attorney-Advisor
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
julie.williams@noaa.gov

Re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3

Dear Ms. Kurkul, Ms. Crocker, & Ms. Williams:

Please accept the following comments on behalf of Riverkeeper, Inc. ("Riverkeeper") regarding National Marine Fisheries Service's ("NMFS") draft Biological Opinion ("draft BiOp") on the effects of the proposed continued operation of Indian Point Nuclear Generating Station ("Indian Point") Units 2 and 3 on endangered aquatic resources in the significant and historic Hudson River.

Riverkeeper is a non-profit environmental watchdog organization that is committed to the protection of the aquatic ecology of the Hudson River, including endangered shortnose sturgeon and threatened candidate species Atlantic sturgeon that reside in the river. To this end, Riverkeeper has historically been engaged in advocacy activities and legal actions involving Indian Point, and, as you are likely aware, is currently a party to the Indian Point operating license renewal proceeding pending before the U.S. Nuclear Regulatory Commission ("NRC"), the Indian Point State Pollutant Discharge Elimination System ("SPDES") permit renewal proceeding, and the Indian Point Clean Water Act § 401 Water Quality Certification proceeding, all of which implicate and involve endangered species issues. Moreover, Riverkeeper retains and regularly consults with the renowned expert fisheries biologists of Pisces Conservation Ltd, on issues pertaining to the aquatic ecology of the Hudson River, and impacts of power plant cooling water intakes thereto. Riverkeeper is, therefore, well situated to provide feedback on the draft BiOp. Furthermore, consideration of Riverkeeper's comments on NMFS's draft BiOp is both necessary and appropriate pursuant to basic tenets of fairness, due process, and the Federal government's commitment to openness, transparency, and public participation.[1] Riverkeeper, thus, thanks NMFS in advance for meaningfully considering the comments submitted herein prior to any issuance of a final Biological Opinion ("final BiOp").

In particular, Riverkeeper respectfully submits the following comments and concerns relating to NMFS's draft BiOp:

The Usefulness of Issuing a Final BiOp at this Time

As a threshold matter, Riverkeeper offers the following comments regarding NMFS's position that it would be strongly advisable for NRC to withdraw its request for consultation.

NMFS's draft BiOp and accompanying cover letter question whether NRC's initiation of consultation pursuant to §7 of the Federal Endangered Species Act was appropriate, as well as the utility of issuing a final BiOp at this time, in light of the uncertain status of ongoing legal proceedings involving Indian Point. In particular, because the New York State Department of Environmental Conservation ("NYSDEC") has denied Entergy a necessary Clean Water Act ("CWA") § 401 Water Quality Certification ("WQC"), it is not clear that Indian Point will even continue to operate, in which case §7 consultation regarding the impact of 20 additional years of operating the plant on endangered species would be unnecessary. Moreover, per NRC's consultation initiation request, NMFS's analysis in the draft BiOp of the potential impacts of the continued operation of Indian Point on endangered resources assumes that the plant will be operated in accordance with the *current* (i.e., 1987 administratively extended) SPDES permit. Because this SPDES permit is presently the subject of a renewal proceeding that will result in the modification of the current permit (since it will require the implementation of the best technology available for minimizing the adverse environmental impacts caused by the current operation of Indian Point's environmentally destructive once-through-cooling water intakes), NMFS points out that the BiOp's "analysis and determinations may need to be modified as the definition of the proposed action and its effects . . . may change." NMFS, therefore, questions

[1] The opportunity to review and comment on the draft BiOp would facilitate Riverkeeper's ability to meaningfully participate in the aforementioned ongoing legal proceedings involving Indian Point and to act as a public advocate, as well as foster an open process that Federal agencies are obligated to strive for. Moreover, given that Riverkeeper's position in various Indian Point proceedings is adverse to that of the owner of Indian Point, Entergy Nuclear Operations, Inc. ("Entergy"), and the NRC, it is patently unfair to allow a one-sided external review of the draft BiOp by only Entergy and the NRC.

whether it is useful to issue a final BiOp before the final outcome of the SPDES permit renewal proceeding is known.[2]

NMFS is correct that without a new, valid CWA § 401 WQC, Indian Point can not continue to operate. While NYSDEC's determination to deny Entergy this necessary certification was definitive, and made within the statutory one-year timeframe contemplated by the CWA, Entergy chose to avail itself of an optional hearing process on the decision, and that process is currently ongoing. NMFS is further correct that the ultimate outcome of the ongoing SPDES permit renewal proceeding will most definitely affect the analysis and conclusions regarding the impacts of Indian Point on endangered species. This proceeding also remains ongoing. Both of these proceedings may not conclude potentially for years.

The eventual outcomes of these proceedings will determine if and how Indian Point might continue to operate, and, thus, more precisely, how the plant would impact endangered species in the Hudson River. Riverkeeper, therefore, agrees with NMFS that NRC's request for §7 consultation regarding a "proposed action" defined as the operation of Indian Point for 20 additional years pursuant to its *existing* (i.e., 1987 administratively extended) SPDES permit was inappropriate and largely ineffective. As such, Riverkeeper further agrees that issuing a final BiOp at this time that is based on this completely inaccurate and irrelevant assumption, is neither appropriate, nor useful.

It is, thus, advisable and necessary for NRC to either withdraw and hold in abeyance its request for §7 consultation pending the outcome of the State proceedings, *or*, request §7 consultation for a "proposed action" that includes and fully accounts for the reasonably foreseeable differing outcomes of these proceedings, and which will result in a thorough analysis of the respective impacts of such differing outcomes. The likely outcomes of the State proceedings are as follows: (1) Indian Point will no longer continue to operate, (2) Entergy will install and operate a closed-cycle cooling system and potentially various other measures related to the water intakes at Indian Point, or (3) Indian Point will continue to operate for 20 years with a once-through cooling water system and cylindrical wedgewire screens.[3]

---

[2] Letter from Patricia A. Kurkul (NMFS) to David J. Wrona (NRC), RE: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Aug. 26, 2011), at 1-2.

[3] NRC may argue that it would not be appropriate to speculate as to the outcome of the pending State proceedings, especially since, as NRC has repeatedly acknowledged, it does not have jurisdiction over issues related to Indian Point's state water permits. *See* In re Entergy Nuclear Operations, Inc. (Indian Point, Units 2 and 3), 68 NRC 43, *156-57 (2008) ("NRC is prohibited from determining whether nuclear facilities are in compliance with CWA limitations, assessing discharge limitations, or imposing additional alternatives to further minimize impacts on aquatic ecology that are subject to the CWA... [T]he NRC has promulgated regulations, specifically 10 C.F.R. § 51.53(c)(3)(ii)(B), to implement these specific CWA requirements that help assure that the Commission does not second-guess the conclusions in CWA-equivalent state permits, or impose its own effluent limitations .... It would be futile for the Board to review any of the CWA determinations, given that it is not possible for the Commission to implement any changes that might be deemed appropriate"). However, asking NMFS to perform a relevant analysis (as opposed to a completely irrelevant and useless one) would clearly not conflict with NRC's lack of authority to substantively opine on Indian Point's CWA-related permits. Moreover, the State proceedings are at a point where at least some reasonably foreseeable outcomes are discernable, as outlined above.

For example, Entergy's proposal that Indian Point be allowed to continue to operate with the installation of cylindrical wedgewire screens,[4] clearly requires additional analysis, as such screens would undoubtedly impact the benthic environment and shortnose sturgeon in the Hudson River: these screens would require an enormous set of underwater structures -- 144 screens each of 72 inches in diameter, made of a metal alloy with toxicity implications -- that would rest on the floor of the river, where, as NMFS's draft BiOp discusses at length, shortnose sturgeon are present for foraging, migrating, avoiding unsuitable thermal temperatures occurring at higher elevations, etc.[5]

In any event, it is axiomatic that NMFS's *relevant* analysis and conclusions must be taken into account in the Indian Point operating license renewal proceeding, and in NRC's ultimate licensing decision. The relicensing proceeding, from which the ESA §7 consultation obligation stems, and associated review processes are occurring now. The ESA §7 consultation is a critical aspect to these reviews. In particular, NMFS's analysis is a critical and necessary component of the National Environmental Policy Act ("NEPA") process in the Indian Point license renewal proceeding. Indeed, the Atomic Safety and Licensing Board ("ASLB") presiding over the Indian Point relicensing case had ruled that "NMFS's BiOp will aid the agency [i.e., NRC] in making its licensing decision in this [relicensing] proceeding. Without receipt and consideration of that input from NMFS, the NRC Staff arguably has not taken the requisite hard look at this issue."[6] As a result, the final environmental impact statement that NRC Staff has already issued in the license renewal proceeding is inadequate without review and consideration of a final BiOp that analyzes all *relevant* issues.

Therefore, whether NRC's §7 consultation request is withdrawn until the State proceedings conclude, or whether NRC redefines the relevant "proposed action" to ensure an accurate and adequate analysis by NMFS, it is clear that NRC must factor NMFS's ultimate analysis and conclusions into the environmental review process concerning the proposed license renewal of Indian Point, and in the final decision regarding whether to grant renewed licenses for the plant.[7]

---

[4] Riverkeeper maintains that such an outcome would not be in compliance with federal and state law.

[5] Notably, in the state CWA § 401 and SPDES proceedings, Entergy has failed to provide any analysis of the adverse environmental impacts associated with the construction and operation of a 144-screen array in the Hudson River.

[6] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3, Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (Ruling on Pending Motions for Leave to File New and Amended Contentions (July 6, 2011), at 69-70.

[7] In the event NRC does not choose either of these options, and proceeds with consultation under the faulty assumption regarding how Indian Point would continue to operate, as NMFS has made clear, re-initiation of consultation will be necessary once the outcome of the State proceedings is known, to account for the inevitable new information and circumstances that will arise. Under such a scenario, NRC, at that time would be obliged to consider NMFS's new/additional analysis and conclusions in the Federal environmental review process concerning the proposed license renewal of Indian Point, and in the final decision regarding whether to grant renewed operating licenses to the facility. For example, as discussed above, should Entergy's proposal to implement cylindrical wedgewire screens at Indian Point ultimately prevail, a new assessment by NMFS would clearly be necessary, as such screens would impact shortnose sturgeon in the Hudson River, which will have to be accounted for in the Federal relicensing case.

Notably, given NRC's noted lack of jurisdiction over CWA-related issues, NRC may not await the outcome of the Indian Point SPDES permit renewal proceeding before attempting to conclude the license renewal proceeding;

In the event that NRC does not either withdraw and hold in abeyance its request for §7 consultation pending the outcome of the State proceedings, or, request §7 consultation for a redefined "proposed action" to ensure an accurate and adequate analysis by NMFS, and NMFS intends to issue a Final BiOp, Riverkeeper submits the following comments on the current draft BiOp:

NMFS's Inadequate Assessment of the Cumulative Impacts to Sturgeon

NMFS recognizes that Indian Point has had and (with the continued use of the existing once-through cooling water intake structure) will continue to have adverse impingement impacts on endangered shortnose sturgeon in the Hudson River. NMFS determined that over the proposed 20 year license extension of Indian Point, the plant could collectively impinge up to 162 shortnose sturgeon (a prospective104 at Indian Point Unit 2, and 58 at Indian Point Unit 3). NMFS has concluded that this loss would be acceptable because it would not have an appreciable affect on the total population of shortnose sturgeon in the Hudson River.

However, NMFS has failed to assess the losses of shortnose sturgeon in the Hudson River in view of all shortnose sturgeon entrainment- and impingement-related losses over *all* intakes of all the power plants in the Hudson River and other relevant waters. All of these intakes taken together are authorized to withdraw trillions of gallons of water every year.[8] While NMFS's draft BiOp discusses the existence of some other impingement related impacts to shortnose sturgeon in the Hudson River (and also discusses other discrete impacts to shortnose sturgeon in the river), NMFS presents no analysis of the combined, total cumulative impacts to shortnose sturgeon, and no assessment of whether, *in light of such overall impacts*, the losses caused by

---

additionally, while NRC may not issue renewed operating licenses for Indian Point unless the plant receives a valid CWA § 401 WQC, this does not prevent NRC from attempting to finalize and conclude all otherwise required analyses and review processes, or from reaching a determination about the appropriateness of relicensing Indian Point from a safety and environmental perspective, which could be executed in the event a valid §401 certification is issued. However, under no circumstances would it be legal for NRC to in any way preclude consideration of the ESA §7 consultation process in the relicensing proceeding: consideration of NMFS's assessment on endangered species impacts is necessary pursuant to NEPA. *See generally*, Riverkeeper, Inc. Consolidated Motion for Leave to File a New Contention and New Contention Concerning NRC Staff's Final Supplemental Environmental Impact Statement (Feb. 3, 2011), *accessible at*, http://www.nrc.gov/reading-rm/adams.html#web-based-adams, ADAMS Accession No. ML110410362 (proffering a legal contention asserting the insufficiency of NRC's final environmental impact statement for failure to account for the ESA §7 consultation process, which was later deemed a valid and adjudicable issue by presiding ASLB). Therefore, if in the future NMFS assesses new, previously unanalyzed information arising out of the ultimate decisions in the now pending State proceedings, this would necessitate a supplemental review and analysis by the NRC in the license renewal proceeding pursuant to NEPA.

[8] *See, e.g.*, NYSDEC Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System Permits for the Roseton 1 & 2, Bowline 1 & 2 and Indian Point 2 & 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties, Hudson River Power Plants FEIS (June 25, 2003) (hereinafter "2003 DEC Hudson River Power Plants FEIS"), at 71 (Responses to Comments), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP6.pdf (indicating in 2003 that "[t]he sheer volumes of water necessary to meet the HRSA [Hudson River Settlement Agreement] plants' cooling requirements are enormous. Together, Indian Point, Roseton, and Bowline are authorized to withdraw *1.69 trillion* gallons per year for cooling water . . . ") (emphasis added).

Indian Point would appreciably affect the species in the river. Fisheries Biologist Dr. Peter Henderson of Pisces Conservation Ltd has advised Riverkeeper that NMFS's BiOp is deficient without such an analysis.[9]

In particular, Dr. Henderson has indicated to Riverkeeper that if Indian Point might kill 104 + 58 individual shortnose sturgeon over the proposed 20 year license renewal period, such losses must be considered as part of an overall loss from *all* water extraction activities. That is, NMFS must assess what losses all power plants combined inflict on shortnose sturgeon.[10] Dr. Henderson's review of NMFS's draft BiOp revealed no sense of the spatial extent of the Hudson River shortnose sturgeon population or threats facing it.[11] There is no articulation, let alone analysis, of the cumulative impacts over the geographical range of this population.

Such an analysis is necessary in order to arrive at any ultimate conclusions regarding the impact of Indian Point on this endangered species, and, if appropriate, to determine further reasonable and prudent measures necessary to minimize impacts to shortnose sturgeon. For example, if the combined impacts to shortnose sturgeon is significant, then each plant must reduce its impact, even if each is not responsible for an appreciable number. NMFS cannot deem the losses caused by Indian Point acceptable in a vacuum, i.e., without putting such losses into proper context, and determining whether such losses are significant in light of all other relevant impacts to the species.

Similarly, while NMFS has concluded that the thermal plume at Indian Point is not likely to kill or otherwise affect shortnose sturgeon in the vicinity of the plant, NMFS has failed to adequately assess the cumulative impacts of power plant thermal plumes on shortnose sturgeon.[12] Dr. Henderson has advised Riverkeeper that while it may be correct that shortnose sturgeon will avoid water that is too warm for them, if there are numerous regions with plumes that are being

---

[9] 2003 DEC Hudson River Power Plants FEIS, at 16, *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP3.pdf ("In addition to impingement and entrainment losses associated with the operation of CWIS, *another concern is the cumulative degradation* of the aquatic environment as a result of: (1) multiple intake structures operating in the same watershed or in the same or nearby reaches; and (2) intakes located within or adjacent to an impaired waterbody. . . . [T]here is concern about the effects of multiple intakes on fishery stocks") (emphasis added); *see also id.* at 54 (Responses to Public Comments), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP5.pdf ("The actual draw-down [i.e., "[t]he direct reduction of the quantity of organisms within the water column by water intakes"] is likely even greater because the three HRSA generating plants (combined with other facilities in the same river reaches) *act cumulatively on the entire aquatic community*") (emphasis added).

[10] It is well known that other power plants impinge and entrain sturgeon, which the draft BiOp acknowledges and describes in part. *See also* NMFS Sturgeon Recovery Plan, at 55 ("The operation of power plants in the upper portions of rivers has the greatest potential for directly affecting sturgeon populations because of the increased incidence of entraining younger and more vulnerable life stages. Documented mortalities of sturgeon have occurred in the Delaware, Hudson, Connecticut, Savannah and Santee rivers. Between 1969 and 1979, 39 shortnose sturgeon were impinged at power plants in the Hudson River (Hoff and Klauda 1979).").

[11] For example, does the population extend into Long Island Sound and other areas of adjacent coast where it is impacted by other intakes?

[12] Riverkeeper has offered comments on the illegality of NYSDEC's proposed issuance of a 75-acre mixing zone to allow the facility to discharge heated effluent to the Hudson and expects that issues related to thermal considerations will be advanced to adjudication shortly.

avoided, NMFS must assess what total loss of habitat may be occurring and whether such loss is appreciable for the species in the Hudson River. This is especially important in light of global climate change, which NMFS recognizes will cause the ambient temperature of the Hudson River to rise over time. NMFS must view the thermal impacts of Indian Point with regard for the broader range of thermal impacts faced (and to be faced) by the species in the river.[13]

NMFS's overall conclusion is that the potential impact of Indian Point during Entergy's proposed 20 year period of extended operation is not "appreciable," and will not reduce the likelihood of survival of shortnose sturgeon in the Hudson River, or the rate of recovery of shortnose sturgeon. However, given NMFS's failure to view any losses of shortnose sturgeon caused by the operation of Indian Point in light of total impacts to this species in the Hudson River, these conclusions are, as yet, dubious.

NMFS's Failure to Consider Impacts of Radioactive Groundwater Contamination at Indian Point on Shortnose Sturgeon

NMFS's draft BiOp noticeably omits any mention, let alone discussion and analysis, of the potential effects on shortnose sturgeon caused by the toxic radionuclide laden contamination plumes that underlie the Indian Point site, which undeniably migrate and release to the Hudson River. Decades of component leaks at Indian Point (including past and current leaks from the Unit 1 and Unit 2 spent fuel pools, underground pipes and structures, and other components), has resulted in extensive plumes of contamination (which contain, *inter alia*, highly toxic strontium-90 and cesium-137, as well as tritium) in the groundwater beneath the Indian Point plant. It is undisputed that this contamination leaches through the bedrock beneath Indian Point, and discharges to the Hudson River.[14] Current and probable future leaks at the plant will add to the existing plumes.[15] Entergy's current "remediation" methodology is Monitored Natural Attenuation,[16] and, thus, this contamination, will persist in the groundwater and continually be discharged to the Hudson River throughout the proposed period of extended operation, and beyond.

---

[13] *See* 2003 DEC Hudson River Power Plants FEIS at 71 (Public Comment Summary), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP6.pdf (indicating in 2003 that "[t]ogether, Indian Point, Roseton, and Bowline are authorized to withdraw 1.69 trillion gallons per year for cooling water, and they discharge 220 trillion BTU of waste heat per year. The volume of once-through cooling water is raised between 15°F and 18°F, depending on the plant, or an average of 16.2°F"); *see also supra* Note 9 (discussing concerns relating to cumulative impacts to aquatic ecology of the Hudson River).

[14] *See* Groundwater Investigation Executive Summary (Indian Point Entergy Center, Buchanan, N.Y., Jan. 2008), at 1 ("The plumes ultimately discharge to the Hudson River to the West").

[15] *See generally*, Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Petition for Full Party Status and Adjudicatory Hearing, (July 10, 2010), *accessible at*, http://www.riverkeeper.org/wp-content/uploads/2010/07/RK-NRDC-SH-Petition-for-Full-Party-Status-Indian-Point-401-WQC-scanned.pdf (last visited Sept. 15, 2011), at 39-48.

[16] *See, e.g.*, GZA GeoEnvironmental, Inc., Hydrogeologic Site Investigation Report, Indian Point Energy Center (Jan. 7, 2008) ("The proposed remediation technology is source elimination/control . . . with subsequent Monitored Natural Attenuation, or MNA.").

Notably, fish samples taken by Entergy in Fall of 2006 showed elevated levels of strontium-90 in their flesh.[17] Moreover, historic Entergy data showed that fish and shellfish in the Hudson River had detectable levels of not only strontium-90, but also strontium-89, a shorter lived isotope that is not usually found in background radiation resulting from historic nuclear weapons testing.[18] Thus, there is every reason to believe, absent any enhanced and regular fish sampling scheme, that because the groundwater contamination at Indian Point directly discharges to the Hudson River, it may be impacting fish in the river.

The lack of analysis by NMFS is particularly troubling given the known dangers of exposure to radioactive substances such as strontium-90 and tritium: Strontium-90 imitates calcium by concentrating in fish bones and shells of clams and blue crab. Clams are a major part of the diet of sturgeon found in the Hudson River. Riverkeeper is, therefore, concerned that Hudson sturgeon are being exposed to elevated levels of this dangerous substance.

Therefore, NMFS's Biological Opinion must analyze the potential effects of the groundwater contamination at Indian Point on shortnose sturgeon. Assessing this issue is a critical aspect of NMFS's overall assessment of impacts to this endangered species, and should certainly be considered in terms of further necessary and appropriate reasonable and prudent measures that should be implemented at Indian Point.

NMFS's Failure to Consider the Indian Point Unit 1 Intake

NMFS does not appear to consider the potential impacts to shortnose sturgeon of the semi-decommissioned Indian Point Unit 1. If the licenses for Indian Point Units 2 and 3 are renewed, Entergy will use some of the systems from Indian Point Unit 1 in the continued operations of the facility.[19] Specifically, the Indian Point Unit 1 intake structure "houses the river water pumps that support Unit 2 service water" and is proposed to be used throughout the period of extended operation to "[p]rovide support, shelter and protection for equipment credited for regulations associated with fire protection."[20] Entergy's License Renewal Application states that travelling screens have been installed at the Unit 1 intake structure.[21] By failing to analyze the effects of the continued use of the Unit 1 Intake Structure, NMFS has ignored another point of impact on the shortnose sturgeon. If Entergy is going to use the intake structure from Unit 1 in the

[17] *See, e.g.*, Greg Clary, *Hudson River Fish Found to Contain Radioactive Isotope*, Westchester County Journal News (Jan. 16, 2007). While Entergy determined that the maximum individual annual dose from consumption of this fish would equal 44% of the annual allowable bone dose to an Adult male, Entergy concluded that additional investigation was warranted in order to understand the elevated levels. *See* IPEC-CHM-07-002, Memorandum from S. Sandike, Sr. Chemistry Specialist to T. Bums, NEM Supervisor, re: "Dose Assessments from Sr-90 in the Hudson River for Fish and Invertebrates-January 2007 Results" (January 17, 2007). However, Entergy has never enhanced fish sampling to determine the full extent of the impact of the radiological contamination on fish in the river.

[18] E-mail from Dara Gray (Entergy) to James Noggle (NRC), with attached table entitled "Historic Strontium Tritium Results" (January 24, 2007).

[19] *See generally,* Indian Point Nuclear Generating Unit Nos. 2 and 3 – License Renewal Application (Apr. 30, 2007), *available at* http://www.nrc.gov/reactors/operating/licensing/renewal/applications/indian-point.html#application ("Entergy LRA").

[20] Entergy LRA § 2.4.2, at 2.4-5.

[21] *Id.* § 2.3.3.19, at 2.3-157.

continued operation of Indian Point, NMFS staff must take into account past and future impingement from Unit 1 in order to accurately analyze the total impacts on the species.

NMFS's Failure to Assess all Reasonable and Prudent Measures

NMFS concludes that potential losses of shortnose sturgeon caused by Indian Point over a proposed 20 period of extended operation are not significant, and therefore, exempts a certain level of impingement. As discussed above, NMFS's conclusions are, at a minimum, uncertain, due to NMFS's failure to properly assess the cumulative impacts to shortnose sturgeon in the Hudson River. Moreover, Riverkeeper respectfully submits that, because of the slow maturation process and intermittent spawning of shortnose sturgeon, (which NMFS's draft BiOp recognizes), *any* impacts on this species may have noticeable affects, and that it is critical that impacts on shortnose sturgeon are kept to a minimum.

In any event (that is, whether NMFS's overall conclusions are supportable or whether the impacts may be more significant than the draft BiOp concludes), due to the availability of a technology that would substantially reduce the impacts to shortnose sturgeon caused by Indian Point, i.e., closed-cycle cooling,[22] Riverkeeper fails to understand why the draft BiOp does not assess the efficacy of this technology as a "reasonable and prudent measure"[23] to be implemented at Indian Point.

While Riverkeeper understands that the outcome of the NYSDEC SPDES permit modification proceeding will ultimately determine whether closed-cycle cooling will be required at Indian Point,[24] there is no reason this should preclude NMFS from examining this technology, and reaching independent conclusions about whether instituting this technology would be beneficial for endangered aquatic resources in the Hudson River.

---

[22] Closed-cycle cooling systems require only a small fraction of the water which is required by once-through cooling systems, and since aquatic mortality is directly related to the amount of water use, a retrofit to a closed-cycle cooling system results in substantial reductions in aquatic mortality. *See* DEC Fact Sheet, New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal With Modification, Indian Point Electric Generating Station, Buchanan, NY – November 2003, at Attachment B, p.3, *available at* http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf (last accessed Sept. 15, 2011) (hereinafter referred to as "DEC Fact Sheet") ("Closed-cycle cooling recirculates cooling water in a closed system that substantially reduces the need for taking cooling water from the River."); *see also, e.g.*, Network for New Energy Choices, *The Truth About Closed-Cycle Cooling* (2010), *available at*, http://www.newenergychoices.org/uploads/fishkill_truth.pdf (last accessed Sept. 15, 2011).

[23] *See* 50 C.F.R. § 402.02 ("*Reasonable and prudent measures* refer to those actions the Director believes necessary or appropriate to minimize the impacts, *i.e.,* amount or extent, of incidental take."); *see id.* § 402.14(g)(8) ("In formulating its biological opinion, . . . and any reasonable and prudent measures, the Service will use the best scientific and commercial data available. . ."); *see also id.* § 402.14(i)(ii) ("the Service will provide with the biological opinion a statement concerning incidental take that: . . . (ii) Specifies those reasonable and prudent measures that the Director considers necessary or appropriate to minimize such impact").

[24] As discussed at length above, in order for the consultation process to be meaningful and useful, NRC should request consultation regarding the reasonably foreseeable outcomes of the ongoing State proceedings, or, in the alternative, withdraw its request for consultation and initiate such consultation in the future after the State proceedings conclude. However, if NRC does not do this, and NMFS and NRC continue the consultation process based on the existing draft BiOp, the efficacy of a closed-cycle cooling system should still be analyzed before finalizing the BiOp.

Thank you for your consideration of the foregoing comments. Please do not hesitate to contact me at 914-478-4501, or via e-mail at dbrancato@riverkeeper.org, to discuss anything further.

Sincerely,

Deborah Brancato

Deborah Brancato
Staff Attorney

Riverkeeper Amended Contention RK-EC-8A:

Attachment 3

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Agency: Nuclear Regulatory Commission

Activity: **Relicensing – Indian Point Nuclear Generating Station F/NER/2009/00619**

Conducted by: NOAA's National Marine Fisheries Service
Northeast Regional Office

Date Issued: OCT 14 2011

Approved by: for PATRICIA KURKUL

INTRODUCTION

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) issued in accordance with section 7 of the Endangered Species Act of 1973, as amended, on the effects of the continued operation of the Indian Point Nuclear Generating Station (Indian Point) pursuant to a renewed operating license proposed to be issued by the Nuclear Regulatory Commission (NRC) in accordance with the Atomic Energy Act of 1954 as amended (68 Stat. 919) and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242).

This Opinion is based on information provided in a Biological Assessment dated December 2010, the *Final Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38 Regarding Indian Point Nuclear Generating Unit 2 and 3* dated December 2010, permits issued by the State of New York, information submitted to NMFS by Entergy and other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Northeast Regional Office, Gloucester, Massachusetts.

BACKGROUND AND CONSULTATION HISTORY

Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) are located on approximately 239 acres (97 hectares (ha)) of land in the Village of Buchanan in upper Westchester County, New York (project location is illustrated in Figures 1 and 2). The facility is on the eastern bank of the Hudson River at river mile (RM) 43 (river kilometer (RKM) 69) about 2.5 miles (mi) (4.0 kilometers (km)) southwest of Peekskill, the closest city, and about 43 mi (69 km) north of the southern tip of Manhattan. Both IP2 and IP3 use Westinghouse pressurized-water reactors and nuclear steam supply systems (NSSSs). Primary and secondary plant cooling is provided by a once-through cooling water intake system that supplies cooling water from the Hudson River. Indian Point Nuclear Generating Station Unit No. 1 (IP1, now permanently shut down[1]) shares

1 The intake for IP1 is usedfor service water for IP2; however, IP1 no longer is used for generating electricity and no cooling water is withdrawn from the IP1 intake. This use is discussed fully below.

the site with IP2 and IP3. IP1 is located between IP2 and IP3. In 1963, IP1 began operations. IP1 was shut down on October 31, 1974, and is in a safe storage condition (SAFSTOR) awaiting final decommissioning. Construction began on IP2 in 1966 and on IP3 in 1969.

IP2 was initially licensed by the Atomic Energy Commission (AEC), the predecessor to the NRC, on September 28, 1973. The AEC issued a 40-year license for IP2 that will expire on September 29, 2013. IP2 was originally licensed to the Consolidated Edison Company, which sold that facility to Entergy in September 2001. IP3 was initially licensed on December 12, 1975, for a 40-year period that will expire in December 2015. While the Consolidated Edison Company of New York originally owned and operated IP3, it was later conveyed to the Power Authority of the State of New York (PASNY – the predecessor to the New York Power Authority [NYPA]). PASNY/NYPA operated IP3 until November 2000 when it was sold to Entergy.

Endangered Species Act Consultation

The Endangered Species Act was enacted in 1973. However, there was no requirement in the 1973 Act for the Secretary to produce a written statement setting forth his biological opinion on the effects of the action and whether the action will jeopardize the continued existence of listed species and/or destroy or adversely modify critical habitat. It was not until Congress amended the Act in 1978 that the Secretary was required to produce a Biological Opinion. The 1973 Act, including as amended in 1978, prohibited the ―take” of endangered species. NMFS could issue a Section 10 incidental take permit to those who applied for incidental take authorization. In 1982, Congress amended the Act to provide for an ―Incidental Take Statement” (ITS) in a Biological Opinion that specifies the level of incidental ―take,” identifies measures to minimize the level of incidental ―take,” and exempts any incidental ―take” that occurs in compliance with those measures. To date, NMFS has not exempted any incidental take at IP2 and IP3 from the Section 9 prohibitions against take, either through a Section 10 permit or an ITS.

As explained below, beginning in 1977, EPA held a series of hearings (Adjudicatory Hearing Docket No. C/II-WP-77-01) regarding the once through cooling systems at Indian Point, Roseton, Danskammer and Bowline Point, all power facilities located along the Hudson River. During the course of these hearings, Dr. Mike Dadswell testified on the effects of the Indian Point facility on shortnose sturgeon. In a filing dated May 14, 1979, NOAA submitted this testimony to the US EPA as constituting NMFS ―Biological Opinion on the impacts of the utilities' once through cooling system on the shortnose sturgeon." The filing notes that this opinion is required by section 7 of the ESA of 1973, as amended.

In this testimony, Dr. Dadswell provides information on the life history of shortnose sturgeon and summarizes what was known at the time about the population in the Hudson River. Dr. Dadswell indicates that at the time it was estimated that there were approximately 6,000 adult and sub-adult shortnose sturgeon in the Hudson River population (Dadswell 1979) and that the population had been stable at this number between the 1930s and 1970s. Dr. Dadswell determined that there is no known entrainment of shortnose sturgeon at these facilities and little, if any, could be anticipated. Based on available information regarding impingement at IP2 and IP3, Dadswell estimated a worst case scenario of 35 shortnose sturgeon impingements per year, including 21 mortalities (assuming 60% impingement mortality). Dadswell estimated that this resulted in a loss of 0.3-0.4% of the shortnose sturgeon population in the Hudson each year and that this additional source of mortality will not “appreciably reduce the likelihood of the survival and recovery of the shortnose sturgeon.” In conclusion Dadswell stated that the once through cooling systems being considered in the case were “not likely to jeopardize the continued existence of the shortnose sturgeon because, even assuming 100% mortality of impinged fish, its contribution to the natural annual mortality is negligible.” Dr. Dadswell did also note that as there is no positive benefit to impingement, any reductions in the level of impingement would aid in the conservation of the species. No additional ESA consultation has occurred between NRC and NMFS on the operation of IP2 and IP3 and the effects on shortnose sturgeon; incidental take associated with IP2 or IP3 has never been exempted.

In advance of the current relicensing proceedings, NRC began coordination with NMFS in 2007. In a letter dated August 16, 2007 NRC requested information from NMFS on Federally listed endangered or threatened species, as well as on proposed or candidate species, and on any designated critical habitats that may occur in the vicinity of IP2 and IP3. In its response, dated October 4, 2007, NMFS expressed concern that the continued operation of IP2 and IP3 could have an impact on the shortnose sturgeon *(Acipenser brevirostrum*). In a letter dated December 22, 2008, NRC requested formal consultation with NMFS to consider effects of the proposed relicensing on shortnose sturgeon. With this letter NRC transmitted a Biological Assessment (BA). In a letter dated February 24, 2009, NMFS requested additional information on effects of the proposed relicensing on shortnose sturgeon. In a letter dated December 10, 2010, NRC provided the information that was available and transmitted a revised BA. In the original BA, NRC staff relied on data originally supplied by the applicant, Entergy Nuclear Operations, Inc. (Entergy). NRC sought and Entergy later submitted revised impingement data, which was incorporated into the final BA. Mathematical errors in the original data submitted to the NRC resulted in overestimates of the impingement of shortnose sturgeon that the NRC staff presented in the 2008 BA.

On June 16, 2011 NMFS received information regarding Entergy’s triaxial thermal plume study and staff obtained a copy of the study and supporting documentation from NYDEC’s webpage on that date. Additional information regarding the intakes was provided by Entergy via conference call on June 20, June 22, and June 29, 2011. Supplemental information responding to specific questions raised by NMFS regarding the thermal plume was submitted by Entergy via e-mail on July 8, July 25, and August 5, 2011. NRC provided NMFS with a supplement to the December 2010 BA considering the new thermal plume information, on July 27, 2011. NMFS transmitted a draft Opinion to NRC on August 26, 2011. The draft Opinion was subsequently transmitted by NRC to Entergy. Comments on the draft Opinion were received by NMFS from NRC on September 6, 2011 and September 20, 2011. Comments were received by NMFS from Entergy on September 6, 2011. Additionally, NMFS received letters regarding the draft Opinion from New York State (dated September 6, 2011) and Hudson Riverkeeper (dated September 15, 2011). Additional clarifying information on the proposed action was received from NRC and Entergy throughout September 2011.

DESCRIPTION OF THE PROPOSED ACTION

The proposed Federal action is the operation of Indian Point Units 2 and 3 pursuant to NRC's proposed renewed power reactor operating licenses to Entergy for IP2 and IP3. The current 40-year licenses expire in 2013 (IP2) and 2015 (IP3). According to NRC, NRC's ―timely renewal" provision (in 10 CFR 2.109(b)) provides that if a license renewal application is timely filed, which NRC asserts the Entergy application was, the current license is not deemed to have expired until the application has been finally determined. Thus, pursuant to this provision, the current operating licenses will not expire until the license renewal proceeding has concluded. NRC's proposed relicensing would authorize the extended operation of IP2 and IP3 for an additional 20 years (i.e., through September 28, 2033 and December 12, 2035, respectively). In this Opinion, NMFS considers the potential impacts of the continued operation of the facility during the extended operation period. Based on the explanation provided by NRC staff in September 2011, that decisions must be made to resolve the significant number of contentions filed in the adjudicatory process, NMFS does not anticipate that either license would be issued prior to the September 28, 2013, date that the first existing license expires.

Details on the operation of the facilities over the extended operating period, as proposed by Entergy in the license application and as described by NRC in the FEIS and BA, are described below. Both units withdraw water from and discharge water to, the Hudson River. As described by NRC in the Final SEIS (NRC 2010), in 1972, Congress assigned authority to administer the Clean Water Act (CWA) to the US Environmental Protection Agency (EPA). The CWA further allowed EPA to delegate portions of its CWA authority to states. On October 28, 1975, EPA authorized the State of New York to issue National Pollutant Discharge Elimination System (NPDES) permits. New York's NPDES, or State Pollutant Discharge Elimination System (SPDES), program is administered by the NY Department of Environmental Conservation (NYDEC). NYDEC issues and enforces SPDES permits for IP2 and IP3.

Section 316(b) of the Clean Water Act of 1977 requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). EPA regulates impingement and entrainment under Section 316(b) of the CWA through the NPDES permit process. Administration of Section 316(b) has also been delegated to NYDEC, and that provision is implemented through the SPDES program.

Neither IP2 or IP3 can operate without cooling water, and NRC is responsible for authorizing the operation of nuclear facilities, as well as approving any extension of an initial operating license through the license renewal process. Intake and discharge of water through the cooling water system would not occur but for the operation of the facility pursuant to a renewed license; therefore, the effects of the cooling water system on shortnose sturgeon are a direct effect of the proposed action. NRC staff state that the authority to regulate cooling water intakes and discharges under the CWA lies with EPA, or in this case, NYDEC, as the state has been delegated NPDES authority by EPA. Pursuant to NRC's regulations, operating licenses are conditioned upon compliance with all applicable law, including but not limited to CWA Section 401 Certifications and NPDES/SPDES permits. Therefore, the effects of the proposed Federal action-- the continued operation of IP2 and IP3 as proposed to be approved by NRC, which necessarily involves the removal and discharge of water from the Hudson River-- are shaped not only by the terms of the renewed operating license but also by the NYDEC 401 Water Quality Certification and any conditions it may contain that would be incorporated into its SPDES permits. This Opinion will consider the effects of the operation of IP2 and IP3 pursuant to the extended Operating License to be issued by the NRC and the SPDES permits issued by NYDEC that are already in effect. NRC requested consultation on the operation of the facilities under the existing NRC license terms and the existing SPDES permits, even though a new SPDES permit might be issued in the future. A complete history of NYDEC permits is included in NRC's FSEIS at Section 2.2.5.3 (Regulatory Framework and Monitoring Programs) and is summarized below.

NPDES/SPDES Permits
Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). In July 2004, the EPA published the Phase II Rule implementing Section 316(b) of the CWA for Existing Facilities (69 FR 41576), which applied to large power producers that withdraw large amounts of surface water for cooling (50 MGD or more) (189,000 m3/day or more). The rule became effective on September 7, 2004 and included numeric performance standards for reductions in impingement mortality and entrainment that would demonstrate that the cooling water intake system constitutes BTA for minimizing impingement and entrainment impacts. Existing facilities subject to the rule were required to demonstrate compliance with the rule's performance standards during the renewal process for their NPDES permit through development of a Comprehensive Demonstration Study (CDS). As a result of a Federal court decision, EPA officially suspended the Phase II rule on July 9, 2007 (72 FR 37107) pending further rulemaking. EPA instructed permitting authorities to utilize best professional judgment in establishing permit requirements on a case by-case basis for cooling water intake structures at Phase II facilities until it has resolved the issues raised by the court's ruling.

The licenses issued by the AEC for IP2 and IP3 initially allowed for the operation of those facilities with once-through cooling systems. However, the licenses required the future installation of closed-cycle cooling systems at both facilities, by certain dates, because of the potential for long term environmental impact from the once-through cooling systems on aquatic life in the Hudson River, particularly striped bass. A closed cycle cooling system is expected to withdraw approximately 90-95% less water than a once through cooling system. The license for IP2 was amended by the NRC in 1975, and the license for IP3 was amended by the NRC in 1976, to include requirements for the installation and operation of wet closed-cycle cooling systems at the facilities.

NRC eventually concluded that the operating licenses for the facilities should be amended to authorize construction of natural draft cooling towers at each Unit. Prior to the respective deadlines for installation of closed-cycle cooling at the Indian Point facilities, however, the NRC's authority to require the retrofit due to water quality impacts under federal nuclear licenses was superseded by comprehensive amendments to the federal Water Pollution Prevention and Control Act (the CWA) and creation of the NPDES program.

In 1975, the EPA issued separate NPDES permits for Units 2 and 3, pursuant to provisions of the CWA, chiefly § 316 (33 U.S.C. § 1326), that required both facilities to discontinue discharging heated effluent from the main condensers. The NPDES permits provided that “heat may be discharged in blowdown from a re-circulated cooling water system.” The intent of these conditions was to require the facilities to install closed-cycle cooling systems in order to reduce the thermal and other adverse environmental impacts from the operation of Indian Point’s CWISs upon aquatic organisms in the Hudson River. In 1977, the facilities’ owners, Consolidated Edison Company of New York and PASNY/NYPA, requested administrative hearings with the EPA to overturn these conditions.

In October 1975, NYDEC received approval from the EPA to administer and conduct a State permit program pursuant to the provisions of the federal NPDES program under CWA § 402. Since then, NYDEC has administered that program under the SPDES permit program. As a result, NYDEC has the authority, under the CWA and state law, to issue SPDES permits for the withdrawal of cooling water for operations at the Indian Point facilities and for the resulting discharge of waste heat and other pollutants into the Hudson River. Compliance with the SPDES permit would be required under the Federal action given that the operating license shall be subject to the conditions imposed under the CWA.

As previously noted, in 1977 the then-owners of the Indian Point nuclear facilities sought an adjudicatory proceeding to overturn the EPA-issued NPDES permit determinations that limited the scope of the facilities’ cooling water intake operations. The EPA’s adjudicatory process lasted for several years before culminating in a multi-party settlement known as the Hudson River Settlement Agreement[1] (HRSA). The HRSA was initially a ten-year agreement whereby the owners of certain once-through cooled electric generating plants on the Hudson River, including IP2 and IP3, would collect biological data and complete analytical assessments to determine the scope of adverse environmental impact caused by those facilities. According to the NYDEC, the intent of the HRSA was that, based upon the data and analyses provided by the facilities, the Department could determine, and parties could agree upon, the best technology available to minimize adverse environmental impact on aquatic organisms in the Hudson River from these facilities in accordance with 6 NYCRR § 704.5. The Settlement obligated the utilities to undertake a series of operational steps to reduce fish kills, including partial outages during the key spawning months. In addition, the utilities agreed to fund and operate a striped bass hatchery, conduct biological monitoring, and set up a $12 million endowment for a new foundation for independent research on mitigating fish impacts by power plants. The agreement became effective upon Public Service Commission approval on May 8, 1981. The terms of the 1980 HRSA were extended through a series of four separate stipulations of settlement and judicial consent orders that were entered in Albany County Supreme Court [Index No. 0191-ST3251]. The last of these stipulations of settlement and judicial consent orders, executed by the parties in 1997, expired on February 1, 1998.

---

1 The signatory parties to the HRSA were USEPA, the Department, the New York State Attorney General, the Hudson River Fishermen’s Association, Scenic Hudson, the Natural Resources Defense Council, Central Hudson Gas & Electric Co., Consolidated Edison Co., Orange & Rockland Utilities, Niagara Mohawk Power Corp., and PASNY. Entergy was not a party to the HRSA because it did not own the Indian Point facilities at any time during the period covered by the HRSA. NOAA was not a party to the HRSA.

In 1982, NYDEC issued a SPDES permit for IP2 and IP3, and other Hudson River electric generating facilities, as well as a CWA § 401 WQC for the facilities. The 1982 SPDES permit for IP2 and IP3 contained special conditions for reducing some of the environmental impact from the facilities' cooling water intakes but, based upon provisions of the HRSA, the permit did not require the installation of any technology for minimizing the number of organisms entrained by the facilities each year. Similarly, based upon provisions of the HRSA, the 1982 § 401 WQC did not make an independent determination that the facilities complied with certain applicable State water quality standards at that time, including 6 NYCRR Part 704 – Criteria Governing Thermal Discharges.

In accordance with the provisions of the HRSA, NYDEC renewed the SPDES permit for IP2 and IP3 in 1987 for another 5-year period. _As with the 1982 SPDES permit, the 1987 SPDES permit for IP2 and IP3 contained certain measures from the HRSA that were intended to mitigate, but not minimize, the adverse environmental impact caused by the operation of the facilities' cooling water intakes. The 1987 SPDES permit expired on October 1, 1992. Prior to the expiration date, however, the owners of the facilities at that time, Consolidated Edison and NYPA, both submitted timely SPDES permit renewal applications to the Department and, by operation of the State Administrative Procedure Act (SAPA), the 1987 SPDES permit for Units 2 and 3 is still in effect today. Entergy purchased Units 2 and 3 in 2001 and 2000, respectively, and the 1987 SAPA-extended SPDES permit for the facilities was subsequently transferred to Entergy.

In November 2003, NYDEC issued a draft SPDES permit for IP2 and IP3 that required Entergy, among other things, to retrofit the Indian Point facilities with closed-cycle cooling or an equivalent technology in order to minimize the adverse environmental impact caused by the CWISs in accordance with 6 NYCRR § 704.5 and CWA § 316(b). The draft permit contains conditions which address three aspects of operations at Indian Point: conventional industrial-wastewater pollutant discharges, thermal discharge, and cooling water intake. Limits on the conventional industrial discharges are not proposed to be changed significantly from the previous permit. The draft permit does, however, contain new conditions addressing the thermal discharge and additional new conditions to implement the measures NYDEC has determined to be the best technology available for minimizing impacts to aquatic resources from the cooling water intake, including the installation of a closed cycle cooling system at IP2 and IP3. With respect to thermal discharges, the draft SPDES permit would require Entergy to conduct a tri-axial (three-dimensional) thermal study to document whether the thermal discharges from IP2 and IP3 comply with state water quality criteria. The draft permit states that if IP2 and IP3 do not meet state standards, Entergy may apply for a modification of those criteria in an effort to demonstrate to NYDEC that such criteria are unnecessarily restrictive and that the requested modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish and wildlife in the Hudson River, which is an applicable CWA water quality-related standard. The draft permit also states that Entergy may propose, within a year of the permit's becoming effective, an alternative technology or technologies that can minimize adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3. In order to implement closed-cycle cooling, the draft permit would require Entergy to submit a pre-design engineering report within one year of the permit's effective date. Within one year after the submission of the report, Entergy must submit complete design plans that address all construction issues for conversion to closed-cycle cooling. In addition, the draft permit requires Entergy to obtain approvals for the system's construction from other government agencies, including modification of the operating licenses for IP2 and IP3 from the NRC. While steps are being taken to implement BTA, Entergy would be required to schedule and take annual generation outages of no fewer than 42 unit-days during the peak entrainment season among other measures. In 2004, Entergy requested an adjudicatory hearing with NYDEC on the draft SPDES permit. That SPDES permit adjudicatory process is presently ongoing, and its outcome is uncertain at this time.

There is significant uncertainty associated with the conditions of any new SPDES permit. In the 2003 draft, NYDEC determined that cooling towers were the BTA to minimize adverse environmental effects. In a 2010 filing with NYDEC, Entergy proposed to use a system of cylindrical wedgewire screens, which Entergy states would reduce impingement and entrainment mortality to an extent comparable to the reductions in impingement and entrainment loss expected to result from operation with cooling towers. As no determination has been made regarding a revised draft SPDES permit or a final permit, it is unknown what new technology, if any, will be required to modify the operation of the facility's cooling water intakes. The 1987 SPDES permit is still in effect and will remain in effect until a new permit is issued and becomes effective. No schedule is available for the issuance of a revised draft or new final SPDES permit and the content of any SPDES permit will be decided as a result of the adjudication process. Therefore, in this consultation, NMFS has considered effects of the operation of the Indian Point facility over the 20-year extended operating period with the 1987 SPDES permit in effect. This scenario is the one defined by NRC as its proposed action in the BA provided to NMFS in which NRC considered effects of the operation of the facility during the extended operating period on shortnose sturgeon. Therefore, it is the subject of this consultation. However, if a new SPDES permit is issued, NRC and NMFS would have to determine if reinitiation of this consultation is necessary to consider any effects of the operation of the facility on shortnose sturgeon that were not considered in this Opinion, including operation of the facility with cylindrical wedge wire screens. It is possible the effects of the construction, layout, and use of an intake system using cylindrical wedge wire screens will affect shortnose sturgeon in a manner and to a degree that is very different from the effects considered in this Opinion.

401 Water Quality Certificate
On April 6, 2009, NYDEC received a Joint Application for a federal CWA § 401 WQC on behalf of Entergy Indian Point Unit 2, LLC, Entergy Indian Point Unit 3, LLC, and Entergy Nuclear Northeast (collectively Entergy). The Joint Application for § 401 WQC was submitted to NYDEC as part of Entergy's NRC license renewal. Pursuant to the CWA, a state must issue a certification verifying that an activity which results in a discharge into navigable waters, such as operation of the Indian Point facilities, meets state water quality standards before a federal license or permit for such activity can be issued. Entergy has requested NYDEC to issue a § 401 WQC to run concurrently with any renewed nuclear licenses for the Indian Point facilities.

In a decision dated April 2, 2010, NYDEC determined that the facilities, whether operated as they are currently or operated with the addition of a cylindrical wedge-wire screen system

(NYDEC notes that this proposal was made by Entergy in a February 12, 2010, submission), –do not and will not comply with existing New York State water quality standards." Accordingly, pursuant to 6 NYCRR Part 621 (Uniform Procedures), NYDEC denied Entergy's request for a §401 WQC (NYDEC 2010). The reasons for denial, as stated by NYDEC were related to impingement and entrainment of aquatic organisms, the discharge of heated effluent, and failure to implement what NYDEC had determined to be the Best Technology Available (closed cycle cooling towers), to minimize adverse environmental impacts. Entergy has appealed the denial. The matter is currently under adjudication in the state administrative system, and the results are uncertain. If New York State ultimately issues a WQC, it may contain conditions that alter the operation of the facility and its cooling water system. If this occurs, NMFS and NRC would need to review the modifications to operations to determine if consultation would need to be reinitiated.

Description of Water Withdrawals

IP2 and IP3 have once-through condenser cooling systems that withdraw water from and discharge water to the Hudson River. The maximum design flow rate for each cooling system is approximately 1,870 cubic feet per second (cfs), 840,000 gallons per minute (gpm), or 53.0 cubic meters per second (m^3/s). Two shoreline intake structures, one for each unit, are located along the eastern shore of the Hudson River on the northwestern edge of the site and provide cooling water to IP2 and IP3. Each structure consists of seven bays, six for circulating water and one for service water. IP2 also uses service water withdrawn from the former IP1 intake, located along the shoreline between the IP2 and IP3 intakes. The IP2 intake structure has seven independent bays, while the IP3 intake structure has seven bays that are served by a common plenum. In each structure, six of the seven bays contain cooling water pumps, and the seventh bay contains service/auxiliary water pumps. Before it is pumped to the condensers, river water passes through traveling screens in the intake structure bays to remove debris and fish.

The six IP2 circulating water intake pumps are dual-speed pumps. When operated at high speed (254 revolutions per minute (rpm)), each pump provides 312 cfs (140,000 gpm; 8.83 m3/s) and a dynamic head of 21 ft (6.4 m). At low speed (187 rpm), each pump provides 38 cfs (84,000 gpm; 5.30 m^3/s) and a dynamic head of 15 ft (4.6 m). The six IP3 circulating water intake pumps are variable-speed pumps. When operated at high speed (360 rpm), each pump provides 312 cfs (140,000 gpm; 8.83 m^3/s); at low speed, it provides a dynamic head of 29 ft (8.8 m) and 143 cfs (64,000 gpm; 4.05 m^3/s).

In accordance with the October 1997 Consent Order (issued pursuant to the HRSA), Entergy adjusts the speed of the intake pumps to mitigate impacts to the Hudson River. Each coolant pump bay is about 15 ft (4.6 m) wide at the entrance, and the bottom is located 27 ft (8.2 m) below mean sea level. Before entering the intake structure bays, water flows under a floating debris skimmer wall, or ice curtain, into the screen wells. This initial screen keeps floating debris and ice from entering the bay. At the entrance to each bay, water also passes through a subsurface bar screen (consisting of metal bars with 3 inch clear spacing) to prevent additional large debris from becoming entrained in the cooling system. At full speed, the approach velocity in front of the screens is 1 foot per second (fps); at reduced speed, the approach velocity is 0.6

fps (Entergy 2007a). As this area is behind a bulkhead it is outside the influence of river currents. Next, smaller debris and fish that pass through the trash bars are screened out using modified Ristroph traveling screens.

The modified Ristroph traveling screens consist of a series of panels that rotate continuously. The traveling screens employed by IP2 and IP3 are modified vertical Ristroph-type traveling screens installed in 1990 and 1991 at IP3 and IP2, respectively. The screens were designed in concert with the Hudson River Fishermen's Association, with screen basket lip troughs to retain water and minimize vortex stress (CHGEC 1999). As each screen panel rotates out of the intake bay, impinged fish are retained in water-filled baskets at the bottom of each panel and are carried over the headshaft, where they are washed out onto a mesh using low-pressure sprays from the rear side of the machine. The 0.25-by-0.5-inch (in.) (0.635-by-1.27 centimeters (cm)) mesh is smooth to minimize fish abrasion by the mesh. Two high-pressure sprays remove debris from the front side of the machine after fish removal. From the mesh, fish return to the river via a 12-in. (30-cm) diameter pipe. For IP2, the pipe extends 200 ft (61.0 m) into the river north of the IP2 intake structure and discharges at a depth of 35 ft (11 m). The sluice system is a 12-in.-diameter (30.5-cm-diameter) pipe that discharges fish into the river at a depth of 35 ft (10.7 m), 200 ft (61 m) from shore (CHGEC 1999). The IP3 fish return system discharges to the river by the northwest corner of the discharge canal.

Studies indicated that, assuming the screens continued to operate as they had during laboratory and field testing, the screens were "the screening device most likely to impose the least mortalities in the rescue of entrapped fish by mechanical means" (Fletcher 1990). The same study concluded that refinements to the screens would be unlikely to greatly reduce fish kills. No monitoring is currently ongoing at IP2 or IP3 for impingement or entrainment or to ensure that the screens are operating per design standards, and no monitoring took place after the screens were installed. Additionally, there is no monitoring ongoing to quantify any actual incidental take of shortnose sturgeon or their prey. The proposed action under consultation, as currently defined by NRC, does not provide for any monitoring of direct or indirect effects to shortnose sturgeon.

After moving through the condensers, cooling water is discharged to the discharge canal via a total of six 96-in. (240-cm) diameter pipes. The cooling water enters below the surface of the 40-ft (12-m) wide canal. The canal discharges to the Hudson River through an outfall structure located south of IP3 at about 4.5 feet per second (fps) (1.4 meters per second (mps)) at full flow. As the discharged water enters the river, it passes through 12 discharge ports (4-ft by 12-ft each (1-m by 3.7-m)) across a length of 252 ft (76.8 m) about 12 ft (3.7 m) below the surface of the river. The increased discharge velocity, about 10 fps (3.0 mps), is designed to enhance mixing to minimize thermal impact.

The discharged cooling water is at an elevated temperature, and therefore, some water is lost because of evaporation. Based on conservative estimates, NRC estimates that this induced evaporation resulting from the elevated discharge temperature would be less than 60 cfs (27,000 gpm or 1.7 m^3/s). This loss is about 0.5 percent of the annual average downstream flow of the Hudson River, which is more than 9000 cfs (4 million gpm or 255 m^3/s). The average cooling water transient time ranges from 5.6 minutes for the IP3 cooling water system to 9.7 minutes for the IP2 system. Auxiliary water systems for service water are also provided from the Hudson River via the dedicated bays in the IP2 and IP3 intake structures. The primary role of service water is to cool components (e.g., pumps) that generate heat during operation. Secondary functions of the service water include the following:

- protect equipment from potential contamination from river water by providing cooling to intermediate freshwater systems;
- provide water for washing the modified Ristroph traveling screens; and,
- provide seal water for the main circulating water pumps.

As noted above, additional service water is provided to the nonessential service water header for IP2 through the IP1 river water intake structure. The IP1 intake includes four intake bays each with a coarse bar screen and a single 0.125-in. (0.318-cm) mesh screen. The intake structure contains two 36-cfs 2 (16,000-gpm; 1.0-m^3/s) spray wash pumps. The screens are washed automatically and materials are sluiced to the Hudson River.

Based on the description of the action provided in the FEIS, no major construction is proposed by Entergy during the relicensing period. Entergy may undertake some refurbishment activities. In the FEIS, NRC indicates that Entergy may replace the reactor vessel heads and control rod drive mechanisms (CRDMs) for IP2 and IP3 during the term of the renewed license. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). There would be no in-water work and there is no indication that effects of this refurbishment activity would extend to the Hudson River. As such, no shortnose sturgeon would be exposed to effects of this refurbishment activity; therefore, effects of this activity are not considered further in this Opinion.

Action Area

The action area is defined in 50 CFR 402.02 as ―all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” IP2 and IP3 are located on a 239-acre (97-hectare) site on the eastern bank of the Hudson River in the village of Buchanan, Westchester County, New York, about 43 miles (mi) (69 kilometers [km) north of the southern tip of Manhattan, New York (Figures 1 and 2). The direct and indirect effects of the Indian Point facility are the intake of water from the Hudson River and the discharge of heated effluent back into the Hudson River. Therefore, the action area for this consultation includes the intake areas of IP1 (for service water), IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3 as described in the Effects of the Action section below.

LISTED SPECIES IN THE ACTION AREA

The only endangered or threatened species under NMFS' jurisdiction in the Action Area is the endangered shortnose sturgeon (*Acipenser brevirostrum*). No critical habitat has been designated for shortnose sturgeon.

COMBINED STATUS OF THE SPECIES/ENVIRONMENTAL BASELINE

This section presents biological and ecological information relevant to formulating the Biological Opinion. Information on the species' life history, its habitat and distribution, and other factors necessary for its survival are included to provide background for analyses in later sections of this opinion. This section reviews the status of the species rangewide as well as the status of the species in the Hudson River. It also presents information to describe the environmental baseline as it is defined by regulation.

Shortnose sturgeon life history

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, isopods), insects, and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[2] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female and a mean of 11,568 eggs/kg body weight (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae

2 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

are believed to begin downstream migrations at about 20mm TL. Dispersal rates differ at least regionally, laboratory studies on Connecticut River larvae indicated dispersal peaked 7-12 days after hatching in comparison to Savannah River larvae that had longer dispersal rates with multiple, prolonged peaks, and a low level of downstream movement that continued throughout the entire larval and early juvenile period (Parker 2007). Synder (1988) and Parker (2007) considered individuals to be juvenile when they reached 57mm TL. Laboratory studies demonstrated that larvae from the Connecticut River made this transformation on day 40 while Savannah River fish made this transition on day 41 and 42 (Parker 2007).

The juvenile phase can be subdivided in to young of the year (YOY) and immature/ sub-adults. YOY and sub-adult habitat use differs and is believed to be a function of differences in salinity tolerances. Little is known about YOY behavior and habitat use, though it is believed that they are typically found in channel areas within freshwater habitats upstream of the salt wedge for about one year (Dadswell et al. 1984, Kynard 1997). One study on the stomach contents of YOY revealed that the prey items found corresponded to organisms that would be found in the channel environment (amphipods) (Carlson and Simpson 1987). Sub-adults are typically described as age one or older and occupy similar spatio-temporal patterns and habitat-use as adults (Kynard 1997). Though there is evidence from the Delaware River that sub-adults may overwinter in different areas than adults and do not form dense aggregations like adults (ERC Inc. 2007). Sub-adults feed indiscriminately; typical prey items found in stomach contents include aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Dadswell 1979, Carlson and Simpson 1987, Bain 1997).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures reach between 7-9.7ºC (44.6-49.5°F), pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 15º (46.4-59°F), and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell et al. 1984; Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° (46.4°F) and 12°C (53.6°F), eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles or sub-adults tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes and move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney et al. 1992; Rogers et al. 1994; Rogers and Weber 1995; Weber 1996).

While shortnose sturgeon do not undertake the significant marine migrations seen in Atlantic sturgeon, telemetry data indicates that shortnose sturgeon do make localized coastal migrations. This is particularly true within certain areas such as the Gulf of Maine (GOM) and among rivers in the Southeast. Interbasin movements have been documented among rivers within the GOM and between the GOM and the Merrimack, between the Connecticut and Hudson rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F) (Dadswell et al. 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). However, water temperatures above 28ºC (82.4°F) are thought to adversely affect shortnose sturgeon. In the Altamaha River, water temperatures of 28-30ºC (82.4-86°F) during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. Dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m (approximately 2 feet) is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m (98.4 ft) but are generally found in waters less than 20m (65.5 ft) (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989); however, shortnose sturgeon forage on vegetated mudflats and over shellfish beds in shallower waters when suitable forage is present.

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were ―in peril…gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as ―vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[3] of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life

3 The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (2005) also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, United States Geological Survey, personal communication; Dionne 2010), while the largest populations are found in the Saint John (~18, 000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species population rangewide, or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery rangewide

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel et al. 1992; Collins et al. 1996). In-water or nearshore construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to riverine habitat which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e. PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the ―adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC. Flourney et al.(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney et al.1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (82.4°F) (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

Global climate change may affect shortnose sturgeon in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers, possibly affecting the survival of drifting larvae and YOY shortnose sturgeon that are sensitive to elevated salinity. Similarly, for river systems with dams, YOY may experience a habitat squeeze between a shifting (upriver) salt wedge and a dam causing loss of available habitat for this life stage.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. One might expect range extensions to shift northward (i.e. into the St. Lawrence River, Canada) while truncating the southern distribution. Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all shortnose sturgeon life stages, including adults, may become susceptible to strandings. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat.

Implications of climate change to shortnose sturgeon throughout their range have been speculated, yet no scientific data are available on past trends related to climate effects on this species and current scientific methods are not able to reliably predict the future magnitude of climate change and associated impacts or the adaptive capacity of this species. While there is a reasonable degree of certainty that certain climate change related effects will be experienced globally (e.g., rising temperatures and changes in precipitation patterns), due to a lack of scientific data, the specific effects to shortnose sturgeon that may result from climate change are not predictable or quantifiable at this time. Information on current effects of global climate change on shortnose sturgeon is not available and while it is speculated that future climate change may affect this species, it is not possible to quantify the extent to which effects may occur. Further analysis on the likely effects of climate change on shortnose sturgeon in the action area is included in the Environmental Baseline and Cumulative Effects sections below.

Status of Shortnose Sturgeon in the Hudson River and Environmental Baseline

The action area is limited to the reach of the Hudson River affected by the operations of IP2 and IP3, including IP1 to the extent its water intake services IP2, as described in the ―Action Area" section above. As such, this section will discuss the available information related to the presence and status of shortnose sturgeon in the Hudson River and in the action area.

Shortnose sturgeon were first observed in the Hudson River by early settlers who captured them as a source of food and documented their abundance (Bain et al. 1998). Shortnose sturgeon in the Hudson River were documented as abundant in the late 1880s (Ryder 1888 in Hoff 1988). Prior to 1937, a few fishermen were still commercially harvesting shortnose sturgeon in the Hudson River; however, fishing pressure declined as the population decreased. During the late 1800s and early 1900s, the Hudson River served as a dumping ground for pollutants that lead to major oxygen depletions and resulted in fish kills and population reductions. During this same time there was a high demand for shortnose sturgeon eggs (caviar), leading to overharvesting. Water pollution, overfishing, and the commercial Atlantic sturgeon fishery are all factors that may have contributed to the decline of shortnose sturgeon in the Hudson River (Hoff 1988).

In the 1930s, the New York State Biological Survey launched the first scientific analysis that documented the distribution, age, and size of mature shortnose sturgeon in the Hudson River (see Bain et al. 1998). In the 1970s, scientific sampling resumed precipitated by the lack of biological data and concerns about the impact of electric generation facilities on fishery resources (see Bain et al. 1998). The current population of shortnose sturgeon has been documented by studies conducted throughout the entire range of shortnose sturgeon in the Hudson River (see: Dovel 1979, Hoff et al. 1988, Geoghegan et al. 1992, Bain et al. 1998, Bain et al. 2000, Dovel et al. 1992).

Several population estimates were conducted throughout the 1970s and 1980s (Dovel 1979; Dovel 1981; Dovel et al. 1992). Most recently, Bain et al. (1998) conducted a mark recapture study from 1994 through 1997 focusing on the shortnose sturgeon active spawning stock. Utilizing targeted and dispersed sampling methods, 6,430 adult shortnose sturgeon were captured and 5,959 were marked; several different abundance estimates were generated from this sampling data using different population models. Abundance estimates generated ranged from a low of 25, 255 to a high of 80,026; though 61,057 is the abundance estimate from this dataset and modeling exercise that is typically used. This estimate includes spawning adults estimated to comprise 93% of the entire population or 56,708, non-spawning adults accounting for 3% of the population and juveniles 4% (Bain et al. 2000). Bain et al. (2000) compared the spawning population estimate with estimates by Dovel et al. (1992) concluding an increase of approximately 400% between 1979 and 1997. Although fish populations dominated by adults are not common for most species, there is no evidence that this is atypical for shortnose sturgeon (Bain et al. 1998).

Woodland and Secor (2007) examined the Bain et al. (1998, 2000, 2007) estimates to try and identify the cause of the major change in abundance. Woodland and Secor (2007) concluded that the dramatic increase in abundance was likely due to improved water quality in the Hudson River which allowed for high recruitment during years when environmental conditions were right, particularly between 1986-1991. These studies provide the best information available on the current status of the Hudson River population and suggests that the population is relatively healthy, large, and particular in habitat use and migratory behavior (Bain et al. 1998).

Shortnose sturgeon have been documented in the Hudson River from upper Staten Island (RM -3 (rkm -4.8)) to the Troy Dam (RM 155 (rkm 249.5); for reference, Indian Point is located at RM 43 (rkm 69))[4] (Bain et al. 2000, ASA 1980-2002). Prior to the construction of the Troy Dam in

4 See Figure 3 for a map of the Hudson River with these areas highlighted.

1825, shortnose sturgeon are thought to have used the entire freshwater portion of the Hudson River (NYHS 1809). Spawning fish congregated at the base of Cohoes Falls where the Mohawk River emptied into the Hudson. In recent years (since 1999), shortnose sturgeon have been documented below the Tappan Zee Bridge from June through December (ASA 1999-2002; Dynegy 2003). While shortnose sturgeon presence below the Tappan Zee Bridge had previously been thought to be rare (Bain et al. 2000), increasing numbers of shortnose sturgeon have been documented in this area over the last several years (ASA 1999-2002; Dynegy 2003) suggesting that the range of shortnose sturgeon is extending downstream. Shortnose sturgeon were documented as far south as the Manhattan/Staten Island area in June, November and December 2003 (Dynegy 2003).

From late fall to early spring, adult shortnose sturgeon concentrate in a few overwintering areas. Reproductive activity the following spring determines overwintering behavior. The largest overwintering area is just south of Kingston, NY, near Esopus Meadows (RM 86-94, rkm 139-152) (Dovel et al. 1992). The fish overwintering at Esopus Meadows are mainly spawning adults. Recent capture data suggests that these areas may be expanding (Hudson River 1999-2002, Dynegy 2003). Captures of shortnose sturgeon during the fall and winter from Saugerties to Hyde Park (greater Kingston reach), indicate that additional smaller overwintering areas may be present (Geoghegan et al. 1992). Both Geoghegan et al. (1992) and Dovel et al. (1992) also confirmed an overwintering site in the Croton-Haverstraw Bay area (RM 33.5 – 38,rkm 54-61). The Indian Point facility is located approximately 8km (5 miles) north of the northern extent of this overwintering area, which is near rkm 61 (RM 38). Fish overwintering in areas below Esopus Meadows are mainly thought to be pre-spawning adults. Typically, movements during overwintering periods are localized and fairly sedentary.

In the Hudson River, males usually spawn at approximately 3-5 years of age while females spawn at approximately 6-10 years of age (Dadswell et al. 1984; Bain et al. 1998). Males may spawn annually once mature and females typically spawn every 3 years (Dovel et al. 1992). Mature males feed only sporadically prior to the spawning migration, while females do not feed at all in the months prior to spawning.

In approximately late March through mid-April, when water temperatures are sustained at 8º-9° C (46.4-48.2°F) for several days[5], reproductively active adults begin their migration upstream to the spawning grounds that extend from below the Federal Dam at Troy to about Coeymans, NY (rkm 245-212 (RM 152-131); located more than 150km (93 miles) upstream from the Indian Point facility) (Dovel et al. 1992). Spawning typically occurs at water temperatures between 10-18°C (50-64.4°F) (generally late April-May) after which adults disperse quickly down river into their summer range. Dovel et al. (1992) reported that spawning fish tagged at Troy were recaptured in Haverstraw Bay in early June. The broad summer range occupied by adult shortnose sturgeon extends from approximately rkm 38 to rkm 177 (RM 23.5-110). The Indian Point facility (at rkm 69) is located within the broad summer range.

---

5 Based on information from the USGS gage in Albany (gage no. 01359139), in 2002 water temperatures reached 8ºC on April 10 and 15ºC on April 20; 2003 - 8ºC on April 14 and 15ºC on May 19; 2004 - 8ºC on April 17 and 15ºC on May 11. In 2011, the most recent year on record, water temperatures reached 8°C on April 11 and reached 15°C on May 19.

There is scant data on actual collection of early life stages of shortnose sturgeon in the Hudson River. During a mark recapture study conducted from 1976-1978, Dovel et al. (1979) captured larvae near Hudson, NY (rkm 188, RM 117) and young of the year were captured further south near Germantown (RM 106, rkm 171). Between 1996 and 2004, approximately 10 small shortnose sturgeon were collected each year as part of the Falls Shoals Survey (FSS) (ASA 2007). Based upon basic life history information for shortnose sturgeon it is known that eggs adhere to solid objects on the river bottom (Buckley and Kynard 1981; Taubert 1980) and that eggs and larvae are expected to be present within the vicinity of the spawning grounds (rkm 245-212, RM 152-131) for approximately four weeks post spawning (i.e., at latest through mid-June). Shortnose sturgeon larvae in the Hudson River generally range in size from 15 to 18 mm (0.6-0.7 inches) TL at hatching (Pekovitch 1979). Larvae gradually disperse downstream after hatching, entering the tidal river (Hoff et al. 1988). Larvae or fry are free swimming and typically concentrate in deep channel habitat (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer ad Kynard 1993). Given that fry are free swimming and foraging, they typically disperse downstream of spawning/rearing areas. Larvae can be found upstream of the salt wedge in the Hudson River estuary and are most commonly found in deep waters with strong currents, typically in the channel (Hoff et al. 1988; Dovel et al. 1992). Larvae are not tolerant of saltwater and their occurrence within the estuary is limited to freshwater areas. The transition from the larval to juvenile stage generally occurs in the first summer of life when the fish grows to approximately 2 cm (0.8 in) TL and is marked by fully developed external characteristics (Pekovitch 1979).

Similar to non-spawning adults, most juveniles occupy the broad region of Haverstraw Bay (rkm 55-64.4) RM 34-40; Indian Point is located near the northern edge of the bay) (Dovel et al. 1992; Geoghegan et al. 1992) by late fall and early winter. Migrations from the summer foraging areas to the overwintering grounds are triggered when water temperatures fall to 8°C (46.4°F) (NMFS 1998), typically in late November[6]. Juveniles are distributed throughout the mid-river region during the summer and move back into the Haverstraw Bay region during the late fall (Bain et al. 1998; Geoghegan et al. 1992; Haley 1998).

Shortnose sturgeon are bottom feeders and juveniles may use the protuberant snout to ―vacuum" the river bottom. Curran & Ries (1937) described juvenile shortnose sturgeon from the Hudson River as having stomach contents of 85-95% mud intermingled with plant and animal material. Other studies found stomach contents of adults were solely food items, implying that feeding is more precisely oriented. The ventral protrusable mouth and barbells are adaptations for a diet of small live benthic animals. Juveniles feed on smaller and somewhat different organisms than adults. Common prey items are aquatic insects (chironomids), isopods, and amphipods. Unlike adults, mollusks do not appear to be an important part of the diet of juveniles (Bain 1997). As adults, their diet shifts strongly to mollusks (Curran & Ries 1937).

---

6 In 2002, water temperatures at the USGS gage at Hastings-on-Hudson (No. 01376304; the farthest downstream gage on the river) fell to 8°C on November 23. In 2003, water temperatures at this gage fell to 8°C on November 29; In 2010, water temperatures at the USGS gage at West Point, NY (No. 01374019; currently the farthest downstream gage on the river) fell to 8°C on November 23.

Telemetry data has been instrumental in informing the extent of shortnose sturgeon coastal migrations. Recent telemetry data from the Gulf of Maine indicate shortnose sturgeon in this region undertake significant coastal migrations between larger river systems and utilize smaller coastal river systems during these interbasin movements (Fernandes 2008; UMaine unpublished data). Some outmigration has been documented in the Hudson River, albeit at low levels in comparison to coastal movement documented in the Gulf of Maine and Southeast rivers. Two individuals tagged in 1995 in the overwintering area near Kingston, NY were later recaptured in the Connecticut River. One of these fish was at large for over two years and the other 8 years prior to recapture. As such, it is reasonable to expect some level of movement out of the Hudson into adjacent river systems; however, based on available information it is not possible to predict what percentage of adult shortnose sturgeon originating from the Hudson River may participate in coastal migrations.

Hudson River Power Plants

The mid-Hudson River provided the cooling water for four other power plants in addition to Indian Point (RM 43 rkm 69): Roseton Generating Station (RM 66, rkm 107), Danskammer Point Generating Station (RM 66, rkm 107), Bowline Point Generating Station (RM 33, rkm 52.8), and Lovett Generating Station (RM 42, rkm 67); all four stations are fossil-fueled steam electric stations, located on the western shore of the river, and all use once-through cooling. Roseton consists of two units and is located 24 miles (38 km) north of IP2 and IP3. Just 0.5 miles (0.9 km) north of Roseton is Danskammer, with four units. Bowline lies about five miles (8 km) south of IP2 and IP3 and consists of two units (Entergy 2007a; CHGEC 1999). Lovett, almost directly across the river from IP2 and IP3, is no longer operating.

In 1998, Central Hudson Gas and Electric Corporation (CHGEC), the operator of the Roseton and Danskammer Point power plants initiated an application for an incidental take (ITP) permit under section 10(a)(1)(B) of the ESA.[7] As part of this process CHGEC submitted a Conservation Plan and application for a 10(a)(1)(B) incidental take permit that proposed to minimize the potential for entrainment and impingement of shortnose sturgeon at the Roseton and Danskammer Point power plants. These measures ensure that the operation of these plants will not appreciably reduce the likelihood of the survival and recovery of shortnose sturgeon in the wild. In addition to the minimization measures, a proposed monitoring program was implemented to assess the periodic take of shortnose sturgeon, the status of the species in the project area, and the progress on the fulfillment of mitigation requirements. In December 2000, Dynegy Roseton L.L.C. and Dynegy Danskammer Point L.L.C. were issued incidental take permit no. 1269 (ITP 1269).

The ITP exempts the incidental take of 2 shortnose sturgeon at Roseton and 4 at Danskammer Point annually. This incidental take level is based upon impingement data collected from 1972-1998. NMFS determined that this level of take was not likely to appreciably reduce the numbers, distribution, or reproduction of the Hudson River population of shortnose sturgeon in a way that

7 CHGEC has since been acquired by Dynegy Danskammer L.L.C. and Dynegy Roseton L.L.C. (Dynegy), thus the current incidental take permit is held by Dynegy. ESA Section 9 prohibits take, among other things, without express authorization through a Section 10 permit or exemption through a Section 7 Incidental Take Statement.

appreciably reduces the ability of shortnose sturgeon to survive and recover in the wild. Since the ITP was issued, the number of shortnose sturgeon impinged has been very low. Dynegy has indicated that this may be due in part to reduced operations at the facilities which results in significantly less water withdrawal and therefore less opportunity for impingement. While historical monitoring reports indicate that a small number of sturgeon larvae were entrained at Danskammer, no sturgeon larvae have been observed in entrainment samples collected since the ITP was issued.

Scientific Studies
The Hudson River population of shortnose sturgeon have been the focus of a prolonged history of scientific research. In the 1930s, the New York State Biological Survey launched the first scientific sampling study and documented the distribution, age, and size of mature shortnose sturgeon (Bain et al. 1998). In the early 1970s, research resumed in response to a lack of biological data and concerns about the impact of electric generation facilities on fishery resources (Hoff 1988). In an effort to monitor relative abundance, population status, and distribution, intensive sampling of shortnose sturgeon in this region has continued throughout the past forty years. Sampling studies targeting other species also incidentally capture shortnose sturgeon.

There are currently three shortnose sturgeon scientific research permits issued pursuant to Section 10(a)(1)(A) of the ESA, in the Hudson River. NYDECs' scientific research permit (#1547) authorizes DEC to conduct river surveys in the Hudson River, specifically focusing on Haverstraw Bay and Newburgh areas to evaluate the seasonal movements of adults and juveniles. NYDEC is authorized to capture up to 500 adults/juveniles annually in order to weigh, measure, tag, and collect tissue samples for genetic analyses. Permit # 1547 expires October 31, 2011.

Scientific research permit # 1575 authorizes Earth Tech, Inc. to conduct a study of fisheries resources in and around the Tappan Zee Bridge in support of the NY Department of Transportation, NY Thruway Authority, and the Metro-North Railroad efforts to improve the mobility in the I-287 corridor including the potential replacement of the Tappan Zee Bridge. Data collection is focused on fish assemblages and relative species abundance in the vicinity of the bridge. Earth Tech, Inc. is authorized to capture, handle, and measure up to 250 adult/juvenile shortnose sturgeon annually. Permit # 1575 expires November 30, 2011.

The third scientific research permit (#1580, originally issued as #1254) is issued to Dynegy[8] to evaluate the life history, population trends, and spacio-temporal and size distribution of shortnose sturgeon collected during the annual Hudson River Biological Monitoring Program. Dynegy is authorized to capture up to 82 adults/juveniles annually to measure, weigh, tag, photograph, and collect tissue samples for genetic analyses. Dynegy is also authorized to lethally take up to 40 larvae annually. Permit # 1580 will expire on March 31, 2012. These permits are issued for a period of five years and may be renewed pending a formal review by NMFS' Office of Protected Resources, Permits Division.

8 Permit 1580 is issued by NMFS to Dynegy on behalf of "other Hudson River Generators including Entergy Nuclear Indian Point 2, L.L.C., Entergy Nuclear Indian Point 3, L.L.C. and Mirant (now GenOn) Bowline, L.L.C."

Impacts of Contaminants and Water Quality

Historically, shortnose sturgeon were rare in the lower Hudson River, likely as a result of poor water quality precluding migration further downstream. However, in the past several years, the water quality has improved and sturgeon have been found as far downstream as the Manhattan/Staten Island area. It is likely that contaminants remain in the water and in the action area, albeit to reduced levels. Sewage, industrial pollutants and waterfront development has likely decreased the water quality in the action area. Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable. Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979).

Principal toxic chemicals in the Hudson River include pesticides and herbicides, heavy metals, and other organic contaminants such as PAHs and PCBs. Concentrations of many heavy metals also appear to be in decline and remaining areas of concern are largely limited to those near urban or industrialized areas. With the exception of areas near New York City, there currently does not appear to be a major concern with respect to heavy metals in the Hudson River, however metals could have previously affected shortnose sturgeon.

PAHs, which are products of incomplete combustion, most commonly enter the Hudson River as a result of urban runoff. As a result, areas of greatest concern are limited to urbanized areas, principally near New York City. The majority of individual PAHs of concern have declined during the past decade in the lower Hudson River and New York Harbor.

PCBs are the principal toxic chemicals of concern in the Hudson River. Primary inputs of PCBs in freshwater areas of the Hudson River are from the upper Hudson River near Fort Edward and Hudson Falls, New York. In the lower Hudson River, PCB concentrations observed are a result of both transport from upstream as well as direct inputs from adjacent urban areas. PCBs tend to be bound to sediments and also bioaccumulate and biomagnify once they enter the food chain. This tendency to bioaccumulate and biomagnify results in the concentration of PCBs in the tissue concentrations in aquatic-dependent organisms. These tissue levels can be many orders of magnitude higher than those observed in sediments and can approach or even exceed levels that pose concern over risks to the environment and to humans who might consume these organisms. PCBs can have serious deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). PCB's may also contribute to a decreased immunity to fin rot (Dovel et al. 1992). Large areas of the upper Hudson River are known to be contaminated by PCBs and this is thought to account for the high percentage of shortnose sturgeon in the Hudson River exhibiting fin rot. Under a statewide toxics monitoring program, the NYSDEC analyzed tissues from four shortnose sturgeon to determine PCB concentrations. In gonadal tissues, where lipid percentages are highest, the average PCB concentration was 29.55 parts per million (ppm; Sloan 1981) and in all tissues ranged from 22.1 to 997.0 ppm. Dovel (1992) reported that more than 75% of the shortnose sturgeon captured in his study had severe incidence of fin rot.

In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). Manufactured Gas Product (MGP) waste, which is chemically similar to the coal tar deposits found in the Connecticut River, is known to occur at several sites within the Hudson River and this waste may have had similar effects on any shortnose sturgeon present in the action area over the years.

Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

Heavy usage of the Hudson River and development along the waterfront could have affected shortnose sturgeon throughout the action area. Coastal development and/or construction sites often result in excessive water turbidity, which could influence sturgeon spawning and/or foraging ability. Industries along the Hudson River have likely impacted the water quality, as service industries, such as transportation, communication, public utilities, wholesale and retail trades, finance, insurance and real estate, repair and others, have increased since 1985 in all nine counties in the lower Hudson River.

The Hudson River is used as a source of potable water, for waste disposal, transportation and cooling by industry and municipalities. Rohman et al. (1987) identified 183 separate industrial and municipal discharges to the Hudson and Mohawk Rivers. The greatest number of users were in the chemical industry, followed by the oil industry, paper and textile manufactures, sand, gravel, and rock processors, power plants, and cement companies. Approximately 20 publicly owned treatment works discharge sewage and wastewater into the Hudson River. Most of the municipal wastes receive primary and secondary treatment. A relatively small amount of sewage is attributed to discharges from recreational boats.

As explained above, the shortnose sturgeon population in the Hudson River is the largest shortnose sturgeon population in the U.S. Studies conducted in the late 1990s indicate that the population may have increased 400% compared to previous studies. The available information indicates that despite facing threats such as power plant entrainments, water quality and in-water construction, the population experienced considerable growth between the late 1970s and late 1990s and is considered to be at least stable at high levels (Woodland and Secor 2007).

Global climate change

The global mean temperature has risen 0.76ºC (1.36°F)over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a) and precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours

(NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b); these trends are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3^{o}-5^{o}C (5^{o}-9^{o}F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2^{o}C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene et al. 2008).

The past 3 decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene et al. 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene et al. 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene et al. 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene et al. 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Hudson River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the United States. Additional information on potential effects of climate change specific to the action area is discussed below. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000); therefore, it is also expected to continue during the course of the renewed licenses (20 years), if issued. It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that they will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch et al. 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch et al. 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer et al. 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer et al. 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2°C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

Effects of climate change on shortnose sturgeon throughout their range
Shortnose sturgeon have persisted for millions of years and throughout this time have experienced wide variations in global climate conditions and have successfully adapted to these changes. As such, climate change at normal rates (thousands of years) is not thought to have historically been a problem for shortnose sturgeon. Shortnose sturgeon could be affected by changes in river ecology resulting from increases in precipitation and changes in water temperature which may affect recruitment and distribution in these rivers. However, as noted in the –Status of the Species" section above, information on current effects of global climate change on shortnose sturgeon is not available and while it is speculated that future climate change may affect this species, it is not possible to quantify the extent to which effects may occur. However, effects of climate change in the action area during the temporal scope of this section 7 analysis (the license renewal periods for IP2/IP3: September 2013 to September 2033 and December 2015 to December 2035) on shortnose sturgeon in the action area are discussed below.

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Hudson River largely focuses on effects that rising water levels may have on the human environment. The New York State Sea Level Rise Task Force (Spector in Bhutta 2010) predicts a state-wide sea level rise of 7-52 inches by the end of this century, with the conservative range being about 2 feet. This compares to an average sea level rise of about 1 foot in the Hudson Valley in the past 100 years. Sea level rise is expected to result in the northward movement of the salt wedge. The location of the salt wedge in the Hudson River is highly variable depending on season, river flow, and precipitation so it is unclear what effect this northward shift could have. Potential negative effects include restricting the habitat available for juvenile shortnose sturgeon which are intolerant to salinity and are present exclusively upstream of the salt wedge. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shift that may occur.

Air temperatures in the Hudson Valley have risen approximately 0.5°C (0.9°F) since 1970. In the 2000s, the mean Hudson river water temperature, as measured at the Poughkeepsie Water Treatment Facility, was approximately 2°C (3.6°C) higher than averages recorded in the 1960s (Pisces 2008). However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Hudson River generally. The Pisces report (2008) also states that temperatures within the Hudson River may be becoming more extreme. For example, in 2005, water temperature on certain dates was close to the maximum ever recorded and also on other dates reached the lowest temperatures recorded over a 53-year period. Other conditions that may be related to climate change that have been reported in the Hudson Valley are warmer winter temperatures, earlier melt-out and more severe flooding. An average increase in precipitation of about 5% is expected; however, information on the effects of an increase in precipitation on conditions in the action area is not available.

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose sturgeon. The most likely effect to shortnose sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north which would restrict the range of juvenile shortnose sturgeon and may affect the development of these life stages. In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of spawning, which would result in a change in the seasonal distribution of sturgeon in the action area. A northward shift in the salt wedge could also drive spawning shortnose sturgeon further upstream which may result in a restriction in the spawning range.

As described above, over the long term, global climate change may affect shortnose sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality; however, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which shortnose sturgeon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect shortnose sturgeon in the action area. Scientific data on changes in shortnose sturgeon distribution and behavior in the action area is not available. Therefore, it is not possible to say with any degree of certainty whether and how their distribution or behavior in the action area have been or are currently affected by climate change related impacts. Implications of potential changes in the action area related to climate change are not clear in terms of population level impacts, data specific to these species in the action area are lacking. Therefore, any recent impacts from climate change in the action area are not quantifiable or describable to a degree that could be meaningfully analyzed in this consultation. However, given the likely rate of climate change, it is unlikely that there will be significant effects to shortnose sturgeon in the action area, such as changes in distribution or abundance, over the time period considered in this consultation (i.e., 2013 through 2035) and it is unlikely that shortnose sturgeon in the action area will experience new climate change related effects not already captured in the description of the status of the species" above concurrent with the proposed action.

Environmental Baseline
Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area.

As described above, the action area is limited to the area where direct and indirect effects of the Indian Point facility are experienced and by definition is limited in the Hudson River to the intake areas of IP1 (for service water), IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3. The discussion below focuses on effects of state, federal or private actions, other than the action under consideration, that occur in the action area.

Federal Actions that have Undergone Formal or Early Section 7 Consultation
The only Federal actions that occur within the action area are the operations of the Indian Point facility and research activities authorized pursuant to Section 10 of the ESA (discussed above). No Federal actions that have undergone formal or early section 7 consultation occur in the action area.

Impacts of the Historical Operation of the Indian Point Facility
IP1 operated from 1962 through October 1974. IP2 and IP3 have been operational since 1973 and 1975, respectively. Since 1963, shortnose sturgeon in the Hudson River have been exposed to effects of this facility. Eggs and early larvae would be the only life stages of shortnose sturgeon small enough to be vulnerable to entrainment at the Indian Point intakes (openings in the wedge wire screens are 6mm x 12.5 mm (0.25 inches by 0.5 inches); eggs are small enough to pass through these openings but, as explained below, do not occur in the action area.

In the Hudson River, shortnose sturgeon eggs are only found at the spawning grounds, which are more than 150km (93 miles) upstream from the Indian Point intakes (Bain 1998; NMFS 1998). As no shortnose sturgeon eggs occur in the action area, no entrainment of shortnose sturgeon eggs would be anticipated. Shortnose sturgeon larvae are found in deep channels, typically above the salt wedge (Buckley and Kynard 1985). In the Hudson River the location of the salt wedge can vary from as far north as Poughkeepsie to as far downstream as Hastings on Hudson (USGS Hudson River Salt Front study webpage) and therefore, could be upstream or downstream of Indian Point. Depending on the location of the salt wedge, in some years salinity may be low enough in the action area for shortnose sturgeon larvae to be present. In laboratory experiments, larvae were nocturnal, and preferred deep water, grey color, and a silt substrate (Richmond and Kynard 1995). Larvae collected in rivers were found in the deepest water, usually within the channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae in the Hudson River are expected to occur in the deep channel (Hoff et al. 1988; Dovel et al. 1992), which is at least 2,000 feet from the intakes. Any larvae in the action area are expected to be at least 20mm in length as that is the size that shortnose sturgeon larvae begin downstream migrations (Buckley and Kynard 1995); while body width measurements are not available, it is possible that some larvae would be small enough to pass through the screen mesh. However, as larvae are typically found in the deep channel, which is more than 2,000 feet from the location of the intakes, it is unlikely that larvae would be entrained in the intakes. As such, it is unlikely that any shortnose sturgeon eggs or larvae were entrained historically at any of the Indian Point intakes.

Studies to evaluate the effects of entrainment at IP2 and IP3 occurred from the early 1970s through 1987; with intense daily sampling during the spring of 1981-1987. As reported by NRC in the FEIS and BA, entrainment monitoring reports list no shortnose sturgeon eggs or larvae at IP2 or IP3. Given what is known about these life stages (i.e., no eggs present in the action area;

larvae only expected to be found in the deep channel area away from the intakes) and the intensity of the past monitoring, it is reasonable to assume that this past monitoring provides an accurate assessment of past entrainment of shortnose sturgeon early life stages. Based on this, it is unlikely that any entrainment of shortnose sturgeon eggs and larvae occurred historically.

NMFS has no information on any monitoring for impingement that may have occurred at the IP1 intakes. Therefore, we are unable to determine whether any monitoring did occur at the IP1 intakes and whether shortnose sturgeon were recorded as impinged at IP1 intakes. Despite this lack of data, given that the IP1 intake is located between the IP2 and IP3 intakes and operates in a similar manner, it is reasonable to assume that some number of shortnose sturgeon were impinged at the IP1 intakes during the time that IP1 was operational; however, based on the information available to NMFS, we are unable to make a quantitative assessment of the likely number of shortnose sturgeon impinged at IP1 during the period during which it was operational.

The impingement of shortnose sturgeon at IP2 and IP3 has been documented. Impingement monitoring, described fully below in the ―Effects of the Action" section, occurred from 1974-1990, during this time period 21 shortnose sturgeon were observed impinged at IP2. Length is available for 6 fish and ranged from 320-710mm. Condition (dead or alive) is also only available for 6 fish, with 5 of the 6 fish reported dead. However, no information on the condition of these fish is available, thus it is not possible to determine as to whether these fish were fresh dead or died previously and drifted into the intakes, nor is it possible to determine whether they were killed by the impingement, by another impact of facility operation, or due to some other cause unrelated to the facility's operation For Unit 3, 11 impinged shortnose sturgeon were recorded. Condition is available for 3 fish, with two of the three dead. Length is also only available for three fish, with lengths of 325, 479 and 600 mm. As reported by Entergy, water temperatures at the time of recovery of shortnose sturgeon from the IP2 and IP3 intakes ranged from 0.5 – 28°C[9]. Collectively at IP2 and IP3, impingements occurred in all months except July and December.

While models of the current thermal plume are available, it is not clear whether this model accurately represents past conditions associated with the thermal plume. As no information on past thermal conditions are available and no monitoring was done historically to determine if the thermal plume was affecting shortnose sturgeon or their prey, it is not possible to estimate past effects associated with the discharge of heated effluent from the Indian Point facility. No information is available on any past impacts to shortnose sturgeon prey due to impingement or entrainment or exposure to the thermal plume. This is because no monitoring of shortnose sturgeon prey in the action area has occurred.

EFFECTS OF THE ACTION

This section of a Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part

9 The tables of shortnose sturgeon take presented by NRC in the December 2010 BA note that water temperatures recorded on the table were estimated from weekly averages. It is unknown whether temperature samples were taken at the intakes or at some other location in the river.

of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects of the proposed action on shortnose sturgeon and their habitat in the action area within the context of the species current status, the environmental baseline and cumulative effects. The effects of the proposed action are the effects of the continued operation of IP2 and IP3 pursuant to renewed licenses proposed to be issued by the NRC pursuant to the Atomic Energy Act. NRC has requested consultation on the proposed extended operation of the facilities under the same terms as in the existing licenses and existing SPDES permits.

The proposed action has the potential to affect shortnose sturgeon in several ways: impingement or entrainment of individual shortnose sturgeon at the intakes; altering the abundance or availability of potential prey items; and, altering the riverine environment through the discharge of heated effluent.

Effects of Water Withdrawal

Under the terms of the proposed renewal license, IP2 and IP3 will withdraw water from the Hudson River for cooling. Both units would utilize once through cooling, assuming no changes are made to the proposed action. Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. According to the draft SPDES permit for the facility, the NYDEC has determined for CWA purposes that the site-specific best technology available to minimize the adverse environmental impacts of the IP cooling water intake structures is closed-cycle cooling (NYDEC 2003b). IP2 and IP3 currently operate pursuant to the terms of the SPDES permits issued by NYDEC in 1987 but administratively extended since then. NYDEC issued a draft SPDES permit in 2003. Its final contents and timeframe for issuance are uncertain, given it is still under adjudication at this time. While it is also uncertain that the facility will be able to operate under the same terms as those in its existing license and SPDES permit, NRC sought consultation on its proposal to renew the license for the facility under the same terms as the existing license and SPDES permit, which authorize once through cooling. NMFS will consider the impacts to shortnose sturgeon of the continued operation of IP2 and IP3 with the existing once through cooling system and existing SPDES permits over the duration of the proposed license renewal period for IP2 and IP3 (i.e., September 2013 to September 2033 and December 2015 to December 2035, respectively). But, it is important to note that changes to the effects of the action, including but not limited to changes in the effects of the cooling water system, as well as changes in other factors, may trigger reinitiation of consultation (see 50 CFR 402.16).

Entrainment of Shortnose sturgeon

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects organisms with limited swimming ability that can pass through the screen mesh, used on the intake systems. Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000 in NRC 2011). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

The southern extent of the shortnose sturgeon spawning area in the Hudson River is approximately RM 118 (rkm 190*),* approximately 75 miles (121 km) upstream of the Indian Point facility. The eggs of shortnose sturgeon are demersal, sinking and adhering to the bottom of the river, and, upon hatching the larvae in both yolk-sac and post-yolk-sac stages remain on the bottom of the river, primarily upstream of RM 110 (rkm 177) (NMFS 2000). Because eggs do not occur near the IP intakes, there is no probability of entrainment. Shortnose sturgeon larvae are 20mm (0.8 inches) in length at the time they begin downstream migrations (Buckley and Kynard 1995). Larvae are typically found in freshwater, above the salt wedge. The location of the salt wedge in the Hudson River varies both seasonally and annually, depending at least partially on freshwater input. In many years, the salt wedge is located upstream of the Indian Point intakes; in those years, larvae would not be expected to occur near the IP intakes as the salinity levels would be too high. However, at times when the salt wedge is downstream of the intakes, which is most likely to occur in the late summer, there is the potential for shortnose sturgeon larvae to be present in the action area. Larvae occur in the deepest water and in the Hudson River, they are found in the deep channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae grow rapidly and after a few weeks are too large to be entrained by the cooling water intake; thus, any potential for entrainment is limited to any period when individuals are small enough to pass through the openings in the mesh screens that coincide with a period when the salt wedge is located downstream of the intakes. Given the distance between the intake and the deep channel (2000 feet; 610 meters) where any larvae would be present if in the action area, larvae are unlikely to occur near the intake where they could be susceptible to entrainment.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system. IP2 and IP3 monitored entrainment from 1972 through 1987. Entrainment monitoring became more intensive at Indian Point from 1981 through 1987, and sampling was conducted for nearly 24 hours per day, four to seven days per week, during the spawning season in the spring. As reported by NRC, entrainment monitoring reports list no shortnose sturgeon eggs or larvae at IP2 or IP3. During the development of the HCP for steam electric generators on the Hudson River, NMFS reviewed all available entrainment data. In the HCP, NMFS (2000) lists only eight sturgeon larvae collected at any of the mid-Hudson River power plants (all eight were collected at Danskammer (approximately 23 miles upstream of Indian Point), and four of the eight may have been Atlantic sturgeon). Entrainment sampling data supplied by the applicant (Entergy 2007b) include large numbers of larvae for which the species could not be determined;

however, NRC has indicated that as sturgeon larvae are distinctive it is unlikely that sturgeon larvae would occur in the ―unaccounted” category as it is expected that if there were any sturgeon larvae in these samples they would have been identifiable. Entergy currently is not required to conduct any monitoring program to record entrainment at IP2 and IP3; however, it is reasonable to use past entrainment results to predict future effects. This is because: (1) there have not been any operational changes that make entrainment more likely now than it was during the time when sampling took place; and, (2) the years when intense entrainment sampling took place overlap with two of the years (1986 and 1987; Woodland and Secor 2007) when shortnose sturgeon recruitment is thought to have been the highest and therefore, the years when the greatest numbers of shortnose sturgeon larvae were available for entrainment. Reliance on the lack of observed entrainment of shortnose sturgeon during sampling at IP2 and IP3 is also reasonable given the known information on the location of shortnose sturgeon spawning and the distribution of eggs and larvae in the river.

NRC was not able to provide NMFS with any historical monitoring data from the IP1 intakes and it is not clear if any monitoring at IP1 ever occurred. However, given that the IP1 intake (used for service water for IP2) is located adjacent to the IP2 and IP3 intakes and that intake velocity and screen size is comparable to IP2 and IP3 it is reasonable to expect that the potential for entrainment of early life stages of shortnose sturgeon at the IP1 intake is comparable to the potential for entrainment of early life stages of shortnose sturgeon at the IP2 and IP3 intakes.

Based on the life history of the shortnose sturgeon, the location of spawning grounds within the Hudson River, and the patterns of movement for eggs and larvae, it is extremely unlikely that any shortnose sturgeon early life stages would be entrained at IP2 and/or IP3. This conclusion is supported by the lack of any eggs or larvae positively identified as sturgeon and documented during entrainment monitoring at IP2 or IP3. Provided that assumption is true, NMFS does not anticipate any entrainment of shortnose sturgeon eggs or larvae over the period of the extended operating license (i.e., September 2013 through September 2033 and December 2015 through December 2035). It is important to note that this determination is dependent on the validity of the assumption that none of the unidentified larvae were shortnose sturgeon. All other life stages of shortnose sturgeon are too big to pass through the screen mesh and could not be entrained at the facility. As NMFS expects that the potential for entrainment of shortnose sturgeon at the IP1 intake is comparable to IP2 and IP3, NMFS does not anticipate any entrainment of any life stage of shortnose sturgeon at the IP1 intake, as used for service water for IP2.

Impingement of Shortnose Sturgeon

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement can kill organisms immediately or contribute to death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwashing and fish return system that the plant operator uses. Below, NMFS considers the available data on the impingement of shortnose sturgeon at the facility and then considers the likely rates of mortality associated with this impingement.

IP2 and IP3 monitored impingement of most fish species daily until 1981, reduced collections to a randomly selected schedule of 110 days per year until 1991, and then ceased monitoring in 1991 with the installation of the modified Ristroph traveling screens. IP2 and IP3 monitored the impingement of sturgeon species daily from 1974 through 1990 (Entergy 2009).

In 2000, NMFS prepared an environmental assessment (EA) for the proposed issuance of an Incidental Take Permit for shortnose sturgeon at the Roseton and Danskammer generating stations on the Hudson River (NMFS 2000). The EA included the estimated total number of shortnose sturgeon impinged IP2 and IP3, with adjustments to include the periods when sampling was not conducted, including the years after 1990 when no impingement monitoring was conducted. In the EA, NMFS reported that between 1972-1998, an estimated total of 37 shortnose sturgeon were impinged at IP2 and 26 at IP3, with an average of 1.4 and 1.0 fish per year, respectively. For the subset time period of 1989-1998, a total of 8 shortnose sturgeon were estimated to have been impinged at IP2 and 8 at IP3, with an average of 0.8 fish per year at each of the two units.

After NRC submitted its 2008 BA, Entergy submitted revised impingement data to NRC to correct certain accounting errors related to sampling frequency. The corrected impingement data for shortnose sturgeon, presented in NRC's 2010 BA, show that from 1975 to 1990, 20 fish were impinged at IP2 and 11 fish were impinged at IP3; this indicates an average of 1.3 shortnose sturgeon per year at IP2 and 0.73 shortnose sturgeon per year at IP3. NRC has stated that the installation of the modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement mortality for shortnose sturgeon; however, because no monitoring occurred after the installation of the Ristroph screens, more recent data are not available and, it is not possible to determine to what extent the modified Ristroph screens may have reduced impingement mortality as compared to pre-1991 levels.

According to information provided by Entergy (Mattson, personal communication, August 2011), approach velocities outside of the trash bars at IP2 and IP3 are approximately 1.0fps at full flow and 0.6fps at reduced flow (Entergy 2007); yearling and older shortnose sturgeon are able to avoid intake velocities of this speed (Kynard, personal communication 2004). Shortnose sturgeon that become impinged at IP2 and IP3 are likely vulnerable to impingement due to previous injury or other stressor, given that individuals in normal, healthy condition should be able to readily avoid the intakes. The trash bars at the IP2 and IP3 intakes have clear spacing of three inches. Shortnose sturgeon adults and some larger juveniles are expected to have body widths greater than three inches; these fish would be too wide to pass through the bars. Smaller juveniles, which are likely to occur in the vicinity of Indian Point (Bain et al. 1998), with body widths less than 3 inches, would have body widths narrow enough to pass through the trash bars and contact the Ristroph screens.

The shortnose sturgeon population in the Hudson River exhibited tremendous growth in the 20 year period between the late 1970s and late 1990s, with exceptionally strong year classes between 1986-1992 thought to have led to resulting increases in the subadult and adult populations sampled in the late 1990s (Woodland and Secor 2007). The period for which impingement sampling occurred partially overlaps with the period of increased recruitment;

however, during the portion of the sampling period that does overlap with the period of increased recruitment (1986-1990) the increases in the shortnose sturgeon population would have been fish less than 4 years old, which represent only a small portion of the overall shortnose sturgeon population. Thus, to predict future impingement rates it is appropriate to adjust the past impingement rates with a correction factor to account for the increased number of shortnose sturgeon in the population. According to data presented by Bain (2000) and Woodland and Secor (2007), there were 4 times as many shortnose sturgeon in the Hudson River in the late 1990s as compared to the late 1970s. There is no figure available for the interim period which would best overlap with the period when impingement sampling occurred. Woodland and Secor state that the population of shortnose sturgeon is currently stable at the high level described also by Bain. Given the four-fold increase in the population, and assuming that the population remains stable at these numbers, there would be 4 times as many shortnose sturgeon that could be potentially impinged at the facility during the 20-year extended operating period as compared to the past monitoring period. Given this, it is reasonable to multiply the past impingement rates by a factor of 4 to predict impingement rates based on the best available population size. Using this method, an impingement rate of 5.2 shortnose sturgeon per year is calculated for IP2 and an impingement rate of 2.9 shortnose sturgeon per year is calculated for IP3. Using this rate, it is estimated that over the 20 year life of the extended operating license, a total of no more than 104 shortnose sturgeon will be impinged at IP2 and no more than 58 shortnose sturgeon will be impinged at IP3.

NMFS considered reviewing impingement data for other Hudson River power plants to determine if this predicted correlation between increases in individuals and increased impingement of individuals would be observed. Long term shortnose sturgeon impingement monitoring is only available for the Roseton and Danskammer facilities. However, since 2000 both facilities have operated at reduced rates and there has been minimal shortnose sturgeon impingement; in every year it has been less than the 2 and 4 impingements estimated respectively for these two facilities. As the Roseton and Danskammer facilities are not currently operating in the same capacity they were in the past, it is not possible to make an accurate comparison of past and present impingement which could serve to verify NMFS assumptions about an increase in the number of individual shortnose sturgeon in the Hudson River resulting in an increase in impingement. However, based on the assumption that, all other factors remain the same (approach velocity, intake volume) the likelihood of impingement should increase with an increase in available individuals. As noted above, the Lovett facility has been closed. The Bowline facility has always operated with extremely low levels of impingement, thought to be primarily due to the location of the intakes in a nearly enclosed embayment of the River where shortnose sturgeon are thought to be unlikely to occur (Bowline Pond) (NMFS 2000).

Before installation of modified Ristroph screen systems in 1991, impingement mortality at IP2 and IP3 was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design of the screens, as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at IP2 and IP3. The Fletcher study reported mortality following an 8-hour holding period in an attempt to account for delayed mortality that may result from injuries suffered during impingement. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad, with mortality rates ranging from 9-62%, depending on species. No evaluation of survival of shortnose sturgeon on the modified Ristroph screens at IP2 or IP3 was made and no monitoring has occurred since the screens were installed in 1991.

PSEG prepared estimates of impingement survival following interactions with Ristroph screens at their Salem Nuclear Generating Station located on the Delaware River (PSEG in Seabey and Henderson 2007); survival of shortnose sturgeon was estimated at 60% following impingement on a conventional screen and 80% following survival at a Ristroph Screen; survival for other species ranged from 0-100%. It is important to note that PSEG did not conduct field verifications with shortnose sturgeon to demonstrate whether these survival estimates are observed in the field. A review by NMFS of shortnose sturgeon impingement information at Salem indicates that all recorded impingements (20 total since 1978; NRC 2010) have been at the trash racks, not on the Ristroph screens. This is consistent with the expectation that all shortnose sturgeon in the vicinity of the Salem intakes would be too large to fit through the trash bars and potentially contact the Ristroph screens. Thus, while there is impingement data from Salem, there is no information on post-impingement survival for shortnose sturgeon impinged on the Ristroph screens. The majority of impinged shortnose sturgeon at Salem have been dead at the time of removal from the trash racks (17 out of 20; 85%),

In his 1979 testimony, Dadswell discussed a mortality rate of shortnose sturgeon at traditional screens of approximately 60%, although it is unclear what information this number is derived from as no references were provided and no explanation was given in the testimony.

No further monitoring of the IP2 or IP3 intakes or impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991, and any actual reduction in mortality or injury to shortnose sturgeon resulting from impingement after installation of these systems at IP2 and IP3 has not been established. As explained above, shortnose sturgeon with a body width of at least three inches would not be able to pass through the trash bars and would become impinged on the trash bars and not pass through to the Ristroph screens. Survival for shortnose sturgeon impinged on the trash bars would be dependent on the length of time the fish was impinged. The available data for shortnose sturgeon impingement at trash bars indicates that mortality is likely to be high (e.g., 85% at Salem nuclear facility) even when a monitoring program is in place designed to observe and remove impinged fish[10].

Of the 32 shortnose sturgeon collected during impingement sampling at IP2 and IP3, condition (alive or dead) is reported for 9 fish (NRC BA 2010); of these, 7 are reported as dead (78% mortality rate). There is no information to indicate whether alive meant alive and not injured, or alive and injured. There is also no additional information to assess whether these fish reported as dead were likely killed prior to impingement and drifted into the intake or whether impingement was the sole cause of death or a contributing cause of death. Similar high levels of mortality

---

10 At Salem, trash racks infront of the intakes are cleaned at least three times per week and the trash bars are inspected every four hours from April through October.

(85%) are observed at the intakes at the Salem Nuclear facility on the Delaware River. As noted above, healthy shortnose sturgeon (yearlings and older) are expected to be able to readily avoid an intake with an approach velocity of 1.0 fps or less. Therefore, any shortnose sturgeon impinged at the trash bars, where the velocity is 1.0 fps or less depending on operating condition, are likely to already be suffering from injury, or illness which has impaired their swimming ability. Past monitoring at IP2 and IP3 indicates that mortality rates are approximately 78%, monitoring at the Salem nuclear facility indicates that mortality rates at the trash bars are approximately 85%. With no monitoring or inspection plan in place to detect and remove shortnose sturgeon that become impinged on the trash bars, mortality rates for shortnose sturgeon impinged on the trash bars are more likely to be as high as 100%, as there would be no opportunity for fish to be removed once stuck between the bars.

Based on the available information, it is difficult to predict the likely mortality rate for shortnose sturgeon following impingement on the Ristroph screens. Shortnose sturgeon passing through the trash bars and becoming impinged on the Ristroph screens are likely to be small juveniles with body widths less than three inches. Based on the 8-hour survival rates reported by Fletcher, it is likely that some percentage of shortnose sturgeon impinged on the Ristroph screens will survive. However, given that shortnose sturgeon that become impinged on the Ristroph screens are likely to be suffering from injuries, illnesses, or other stressors that have impaired their swimming ability and prevented them from being able to escape from the relatively low approach velocity (1.0 fps or less as measured within the intake bay in front of the Ristroph screens, which yearling and older shortnose sturgeon are expected to be able to avoid (Kynard, pers comm.. 2004)), unknowns regarding injuries and subsequent mortality and without any site-specific studies to base an estimate or even species-specific studies at different facilities, NMFS will assume the worst case, that all individual shortnose sturgeon impinged at IP2 and IP3 will die as a result of impingement.

In addition to the withdrawal of water from the IP2 and IP3 intakes for cooling water and service water, additional service water for IP2 will be withdrawn from the IP1 intakes. This intake is located between the IP2 and IP3 intakes, also along the eastern shore of the Hudson River. NRC was not able to provide NMFS with any monitoring data from IP1 and it is unclear if any monitoring at IP1 has ever occurred. Given the lack of intake specific monitoring data, NMFS has assessed the likelihood of impingement of shortnose sturgeon at the IP1 intakes as compared to the likelihood of impingement at the IP2 and IP3 intakes. As noted above, there is no geographic difference in intake location which would make impingement at IP1 more or less likely at IP2 or IP3. The intake velocity, trash bar spacing and screen mesh size are also comparable between IP1 and IP2 and IP3. The major difference between the IP1 intake and the IP2 and IP3 intakes is the volume of water removed. Together, IP2 and IP3 remove a maximum flow of approximately 1.746 million gallons per minute. According to information provided by Entergy[11], The IP1 intake structure has two redundant forebays, each with a maximum or design flow of 10,000 gpm; however, as currently configured in a redundant manner, the maximum flow of the intake is 10,000 gpm. Entergy further indicates that the typical peak operating flow for IP1 is 5,500 gpm with 6,000 gpm as the limit of the IP2 load.

11 Email from Elise Zoli, representing Entergy, to NMFS and NRC on September 21, 2011.

Given the maximum 6,000 gpm operation of the IP1 intake, this represents approximately 0.34% of the total intake flow from IP2 and IP3. Assuming, that all other parameters being equal, the potential for impingement is related to the volume of water withdrawn, NMFS would expect that during the 20 year period that IP2 might be operating under the extended operating license, the number of shortnose sturgeon impinged at the IP1 intakes would be 0.34% of the number of shortnose sturgeon impinged at IP2 and IP3. As explained above, NMFS has calculated that 162 shortnose sturgeon are likely to impinged at the IP2 and IP3 intakes over the 20 year extended operating period. Based on the assumptions outlined here, NMFS anticipates that up to 6 shortnose sturgeon could be impinged at the trash racks or screens at the IP1 intake, used for service water for IP2. These impingements would occur during the 20 year time period that IP2 might be operating under a renewed operating license (September 2013 – September 2033).

Using the impingement rates calculated above, and the worst case mortality rate of 100% at both the modified Ristroph screens and the trash bars, an average of 5 shortnose sturgeon may die each year as a result of impingement at IP2 and an average of 3 shortnose sturgeon may die each year as a result of impingement at IP3; for a total of 104 at IP2 and 58 at IP3 over the extended 20-year operating license. Additionally, NMFS assumes that the mortality rate at the IP1 intake would be comparable to the mortality rate at IP2 and IP3. NMFS expects that an additional 6 shortnose sturgeon may die at the IP1 intake as a result of impingement at this intake over the 20 year extended operating period for IP2. NMFS believes that the 100% mortality estimate is a conservative, yet reasonable, mortality rate for impinged shortnose sturgeon at the trash bars and Ristroph screens.

Effects of Impingement and Entrainment on Shortnose sturgeon prey
Shortnose sturgeon feed primarily on benthic invertebrates. As these prey species are found on the bottom and are generally immobile or have limited mobility and are not within the water column, they are less vulnerable to impingement or entrainment. Impingement and entrainment studies have not included macroinvertebrates as focus species. No macroinvertebrates are represented in the Representative Important Species (RIS) species focused on by NRC in the FSEIS. However, given the life history characteristics (sessile, benthic, not suspended in or otherwise occupying the water column) of shortnose sturgeon forage items which make impingement and entrainment unlikely, any loss of shortnose sturgeon prey due to impingement or entrainment is likely to be minimal. Therefore, NMFS has determined that the effect on shortnose sturgeon due to the potential loss of forage items caused by impingement or entrainment in the IP1, IP2 or IP3 intakes is insignificant and discountable.

Summary of Effects of Water Withdrawal
The extended operation of IP2 and IP3 would be authorized by the NRC through the issuance of renewed operating licenses. Given that facilities with a once-through cooling water system cannot operate without the intake and discharge of water, and with applicable Clean Water Act provisions would be conditions of the proposed renewed licenses, the effects of water withdrawals are effects of the proposed action. In the analysis outlined above, NMFS has determined the impingement of shortnose sturgeon is likely to occur at IP2 and IP3 over the extended operating period as well as at the IP1 intake which will be used for withdrawing service water for the operation of IP2. NMFS has estimated, using the impingement and mortality rates

calculated above, that each year an average of 5 shortnose sturgeon may die as a result of impingement at IP2 and an average of 3 shortnose sturgeon may die as a result of impingement at IP3, an additional 6 shortnose sturgeon are likely die as a result of impingement at the IP1 intake over the 20 year operating period; for a total of 6 at IP1 intakes, 104 at IP2 and 58 at IP3 over the 20 year operating license. NMFS believes that the 100% mortality estimate is a conservative, yet reasonable estimate of the likely mortality rate for impinged shortnose sturgeon at the Ristroph screens. Due to the size of shortnose sturgeon that occur in the action area, no entrainment at any of the IP intakes is anticipated. Any effects to shortnose sturgeon prey from the continued operation of IP2 and IP3, as defined by the proposed action, would be insignificant and discountable.

Effects of Discharges to the Hudson River
The discharge of pollutants from the IP facility is regulated for CWA purposes through the New York SPDES program. The SDPES permit (NY-0004472) specifies the discharge standards and monitoring requirements for each discharge. Under this regulatory program, Entergy treats wastewater effluents, collects and disposes of potential contaminants, and undertakes pollution prevention activities.

As explained above, Entergy's 1987 SPDES permit remains in effect while NYDEC administrative proceedings continue on a new draft permit. As such, pursuant to NRC's consultation request, the effects of the IP facility continuing to operate under proposed renewed licenses and under the terms of the 1987 SPDES permit will be discussed below.

Heated Effluent
As indicated above, the extended operation of IP2 and IP3 would be regulated by the NRC through the issuance of renewed operating licenses. Given the facilities with a once-through cooling water system cannot operate without the intake and discharge of water, and any limitations or requirements necessary to assure compliance with applicable Clean Water Act provisions would be conditions of the proposed renewed licenses, the effects of discharges are effects of the proposed action. Thermal discharges associated with the operation of the once through cooling water system for IP2 and IP3 are regulated for CWA purposes by the terms of the SPDES permit. Temperature limitations are established and imposed on a case-by-case basis for each facility subject to NYCRR Part 704. Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR Part 704 as follows:

(5) Estuaries or portions of estuaries.

i. The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point.
ii. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or a maximum of 83°F, whichever is less.
iii. From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than an 83°F

increase in temperature not to exceed 1.5°F at any point of the estuarine passageway as delineated above, may be permitted.

iv. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than 4°F from the temperature that existed immediately prior to such lowering.

Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified by NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110°F (43°C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2°F (34°C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2°F (34°C) on more than 15 days during that period in any year.

The discharge of heated water has the potential to cause lethal or sublethal effects on fish and other aquatic organisms and create barriers, preventing or delaying access to other areas within the river. Limited information is available on the characteristics of the thermal plume associated with discharges from IP2 and IP3. As water withdrawn through the IP1 intakes will be used for service water, not cooling water, the discharge of this water is not heated. Below, NMFS summarizes the available information on the thermal plume, discusses the thermal tolerances of shortnose sturgeon, and considers effects of the plume on shortnose sturgeon and their prey.

Characteristics of Indian Point's Thermal Plume

Thermal studies at IP2 and IP3 were conducted in the 1970s. These studies included thermal modeling of near-field effects using the Cornell University Mixing Zone Model (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology (MIT) dynamic network model (also called the far-field thermal model). For the purpose of modeling, near-field was defined as the region in the immediate vicinity of each station discharge where cooling water occupies a clearly distinguishable, three-dimensional temperature regime in the river that is not yet fully mixed; far-field was defined as the region farthest from the discharges where the plumes are no longer distinguishable from the river, but the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed sufficient by the utilities and their contractor and was designed and configured to account for time-variable hydraulic and meteorological conditions and heat sources of artificial origins. Model output included a prediction of temperature distribution for the Hudson River from the Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the permit applicants applied CORMIX modeling to develop a three-dimensional plume configuration of near-field thermal conditions that could be compared to applicable water quality criteria.

The former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September. These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

i. Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.
ii. Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each station, and concurrent operation of all three generating stations at maximum permitted capacity (CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX model runs were integrated with the riverwide temperature profiles developed by the MIT dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises above ambient) for various operating scenarios, the surface width of the plume, the depth of the plume, the percentage of surface width relative to the river width at a given location, and the percentage of cross-sectional area bounded by the 4°F (2°C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999). For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86°F (1.18 to 1.59°C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4°F (2°C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24°F (1.80°C) during June ebb tides to 4.63°F (2.57°C) during flood tides in August. Temperature increases exceeded 4°F (2°C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4°F (2°C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events.

Exceedences generally occurred under scenarios that Entergy indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding, CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

Information provided by Entergy during the consultation period indicates that the CORMIX model has significant limitations which limit its utility when considering the discharge of heated effluent into the Hudson River. Specifically, the CORMIX model results in an overestimate of the scope and extent of the thermal plume. As more recent information on the thermal plume is available (see below) and this new information has been reviewed by NYDEC and determined to be appropriate to use when considering the effects of the thermal discharge on the Hudson River, NMFS is not relying on the CORMIX model in our effects analysis, but rather is relying on the more recent triaxial thermal plume study described below.

More recently, a triaxial thermal plume study was completed. Swanson et al. (2011 b) conducted thermal sampling and modeling of the cooling water discharge at Indian Point and reported that the extent and shape of the thermal plume varied greatly, primarily in response to tidal currents. For example, the plume (illustrated as a 4°F temperature increase or LH isotherm, Figure 5-6 in Swanson et al. 2011 b) generally followed the eastern shore of the Hudson River and extended northward from Indian Point during flood tide and southward from Indian Point during ebb tide. Depending on tides, the plume can be well-defined and reach a portion of the near-shore bottom or be largely confined to the surface.

Temperature measurements reported by Swanson et al. (2011 b) generally show that the warmest water in the thermal plume is close to the surface and plume temperatures tend to decrease with depth. Occasionally, the thermal plume extends deeply rather than across the surface. A cross-river survey conducted in front of Indian Point captured one such incident during spring tide on July 13, 2010 (Figure 3-28 in Swanson et al. 2011b). Across most of the river, water temperatures were close to 82°F (28°C), often with warmer temperatures near the surface and cooler temperatures near the bottom. The Indian Point thermal plume at that point was clearly defined and extended about 1000 ft (300 m) from shore. Surface water temperatures reached about 85°F (29°C). At 23-ft to about 25-ft (7-m to 8-m) depths, observed plume temperatures were 83° to 84°F (28° to 29°C). Maximum river depth along the measured transect is approximately 50 ft (15 m).

A temperature contour plot of a cross-river transect at Indian Point prepared in response to a NYSDEC review illustrates a similar condition on July 11, 2010 during slack before flood tide (Swanson et al. 2011a, Figure 1-10). Here the thermal plume is evident to about 2000 ft (600 m) from the eastern shore (the location of the Indian Point discharge) and extends to a depth of about 35 ft (11 m) along the eastern shore. Bottom temperatures above 82°F (28°C), were confined to about the first 250 ft (76 m) from shore. The river here is over 4500 ft (1400 m) wide. In that small area, bottom water temperatures might also exceed 30°C (86°F); elsewhere, bottom water temperatures were about 80°F (27°C). These conditions would not last long, however, as they would change with the tidal cycle. Further, any sturgeon in this location would be able to retreat to adjacent deeper and cooler water. Under no conditions did interpolated temperatures in Entergy's modeled results exceed the 28°C in the deep reaches of the river channel (Swanson 2011 a).

In response to the NYSDEC's review of the Indian Point thermal studies (Swanson et al. 2011 b), Mendelsohn et al. (2011) modeled the maximum area and width of the thermal plume (defined by the 4°F (2°C) ΔT isotherms) in the Hudson River. Mendelsohn, et al. reported that for four cross-river transects near IP2 and IP3, the maximum cross-river area of the plume would not exceed 12.3 percent and the maximum cross-river width of the plume would not exceed 28.6 percent of the river (Mendelsohn, et al.'s Table 3-1).

Thermal Tolerances – Shortnose sturgeon

Most organisms can acclimate (i.e. metabolically adjust) to temperatures above or below those to which they are normally subjected. Bull (1936) demonstrated, from a range of marine species, that fish could detect and respond to a temperature front of 0.03 to 0.07°C (0.05 – 0.13°F). Fish will therefore attempt to avoid stressful temperatures by actively seeking water at the preferred temperature.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F)(Dadswell et al. 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). Foraging is known to occur at temperatures greater than 7°C (44.6°F) (Dadswell 1979). In the Altamaha River, temperatures of 28-30ºC (82.4-86°F) during summer months are correlated with movements to deep cool water refuges. Ziegeweid et al. (2008a) conducted studies to determine critical and lethal thermal maxima for young-of-the-year (YOY) shortnose sturgeon acclimated to temperatures of 19.5 and 24.1°C (67.1 – 75.4°F). Lethal thermal maxima were 34.8°C (±0.1) and 36.1°C (±0.1) (94.6°F and 97°F) for fish acclimated to 19.5 and 24.1°C (67.1°F and 75.4°F), respectively. The study also used thermal maximum data to estimate upper limits of safe temperature, final thermal preferences, and optimum growth temperatures for YOY shortnose sturgeon. Visual observations suggest that fish exhibited similar behaviors with increasing temperature regardless of acclimation temperature. As temperatures increased, fish activity appeared to increase; approximately 5–6°C (9-11°F) prior to the lethal endpoint, fish began frantically swimming around the tank, presumably looking for an escape route. As fish began to lose equilibrium, their activity level decreased dramatically, and at about 0.3°C (0.54°F)before the lethal endpoint, most fish were completely incapacitated. Estimated upper limits of safe temperature (ULST) ranged from 28.7 to 31.1°C (83.7-88°F)and varied with acclimation temperature and measured endpoint. Upper limits of safe temperature (ULST) were determined by subtracting a safety factor of 5°C (9°F) from the lethal and critical thermal maxima data. Final thermal preference and thermal growth optima were nearly identical for fish at each acclimation temperature and ranged from 26.2 to 28.3°C (79.16-82.9°F). Critical thermal maxima (the point at which fish lost equilibrium) ranged from 33.7 (±0.3) to 36.1°C (±0.2) (92.7-97°F) and varied with acclimation temperature. Ziegeweid et al. (2008b) used data from laboratory experiments to examine the individual and interactive effects of salinity, temperature, and fish weight on the survival of young-of-year shortnose sturgeon. Survival in freshwater declined as temperature increased, but temperature tolerance increased with body size. The authors conclude that temperatures above 29°C (84.2°F) substantially reduce the probability of survival for young-of-year shortnose sturgeon. However, previous studies indicate that juvenile sturgeons achieve optimum growth at temperatures close to their upper thermal survival limits (Mayfield and Cech 2004; Allen et al. 2006; Ziegeweid et al. 2008a), suggesting that shortnose sturgeon may seek out a narrow temperature window to maximize somatic growth without substantially increasing maintenance metabolism. Ziegeweid (2006) examined thermal tolerances of young of the year shortnose sturgeon in the lab. The lowest temperatures at which mortality occurred ranged from 30.1 – 31.5°C (86.2-88.7°F) depending on fish size and test conditions. For shortnose sturgeon, dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Effect of Thermal Discharge on Shortnose Sturgeon

Lab studies indicate that thermal preferences and thermal growth optima for shortnose sturgeon range from 26.2 to 28.3°C (79.2-83°F). This is consistent with field observations which correlate movements of shortnose sturgeon to thermal refuges when river temperatures are greater than 28°C (82.4°F) in the Altamaha River. Lab studies (see above; Ziegeweid et al. 2008a and 2008b) indicate that thermal maxima for shortnose sturgeon are 33.7(±0.3) – 36.1(±0.1) (92.7-97°F), depending on endpoint (loss of equilibrium or death) and acclimation temperature. Upper limits of safe temperature were calculated to be 28.7 – 31.1°C (83.7-88°F). At temperatures 5-6°C (9-11°F) less than the lethal maximum, shortnose sturgeon are expected to begin demonstrating avoidance behavior and attempt to escape from heated waters; this behavior would be expected when the upper limits of safe temperature are exceeded.

NMFS first considers the potential for shortnose sturgeon to be exposed to temperatures which would most likely result in mortality (33.7°C (92.66°F) or greater). The maximum observed temperature of the thermal discharge is approximately 35°C (95°F). Modeling has demonstrated that the surface area of the river affected by the Indian Point plume where water temperatures would exceed 32.22°C (90°F) would be limited to an area no greater than 75 acres. Information provided by Entergy and presented in the recent thermal model (Swanson et al. 2011) indicate that water temperatures at the river bottom will not exceed 32.2°C (90°F) in waters more than 5 meters (16.4 feet) from the surface. Water depths in the area are approximately 18 meters (59 feet). Given this information, it is unlikely that shortnose sturgeon remaining near the bottom of the river would be exposed to water temperatures of 33.7°C (92.7°F). Temperatures at or above 33.7°C (92.7°F) will occasionally be experienced at the surface of the river in areas closest to the discharge point. However, given that fish are known to avoid areas with unsuitable conditions and that shortnose sturgeon are likely to actively avoid heated areas, as evidenced by shortnose sturgeon known to move to deep cool water areas during the summer months in southern rivers, it is likely that shortnose sturgeon will avoid the area where temperatures are greater than tolerable. As such, it is extremely unlikely that any shortnose sturgeon would remain within the area where surface temperatures are elevated to 33.7°C (92.7°F) and be exposed to potentially lethal temperatures. This risk is further reduced by the limited amount of time shortnose sturgeon spend near the surface, the small area where such high temperatures will be experienced and the gradient of warm temperatures extending from the outfall; shortnose sturgeon are likely to begin avoiding areas with temperatures greater than 28°C (82.4°F) and are unlikely to remain within the heated surface waters to swim towards the outfall and be exposed to temperatures which could result in mortality. Below, NMFS considers what effect this avoidance behavior would have on individual shortnose sturgeon. Near the bottom where shortnose sturgeon most often occur, water temperatures are not likely to ever reach 33.7°C (92.7°F), creating no risk of exposure to temperatures likely to be lethal near the bottom of the river.

NMFS has also considered the potential for shortnose sturgeon to be exposed to water temperatures greater than 28°C (82.4°F). Some researchers suggest, based largely on observations of sturgeon behavior in southern rivers, that water temperatures of 28°C (82.4°F)or greater can be stressful for sturgeon and that shortnose sturgeon are likely to actively avoid areas with these temperatures. This temperature (28°C; (82.4°F)) is close to both the final thermal preference and thermal growth optimum temperatures that Ziegeweid et al. (2008) reported for juvenile shortnose sturgeon acclimated to 24.1 °C (75.4 °F), and thus is consistent with observations that optimum growth temperatures are often near the maximum temperatures fish can endure without experiencing physiological stress.

In the summer months (June – September) ambient river temperatures can be high enough that temperature increases as small as 1-4°C (1.8-7.2°C) may cause water temperatures within the plume to be high enough to be avoided by shortnose sturgeon (greater than 28°C (82.4°F)). When ambient river temperatures are at or above 28°C (82.4°F) , the area where temperatures are raised by more than 1.5°C (2.7°F) are expected to be limited to a surface area of up to 75 acres. Shortnose sturgeon exposure to the surface area where water temperature may be elevated above 28°C (82.4°F)due to the influence of the thermal plume is limited by their normal behavior as benthic-oriented fish, which results in limited occurrence near the water surface. Any surfacing shortnose sturgeon are likely to avoid near surface waters with temperatures greater than 28°C (82.4°F). Reactions to this elevated temperature are expected to consist of swimming away from the plume by traveling deeper in the water column or swimming around the plume. As the area that would be avoided is at or near the surface, away from bottom waters where shortnose sturgeon spend the majority of time and complete all essential life functions that are carried out in the action area(foraging, migrating, overwintering, resting), and given the small area that may have temperatures elevated above 28°C (82.4°F) it is extremely unlikely that these minor changes in behavior will preclude shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

Under no conditions did interpolated temperatures in Entergy's modeled results exceed 28°C (82°F) in the deep reaches of the river channel (Swanson 2011 a) where shortnose sturgeon are most likely to occur. Swanson also examined other sources of available bottom water temperature data for the Indian Point area. Based upon examination of the 1997 through 2010 long river survey water temperature data from the near-bottom stations near Indian Point, 28°C (82.4°F) was exceeded for just 56 of 1,877 observations or 2.98% during this 14-year period (readings measured weekly from March through November). These already low incidences of observed near-bottom water temperatures above 28°C (82.4°F) would be even lower when viewed in the context of an entire year instead of the nine months sampled due to the cold water period not sampled from December through February (i.e., 2.24% for the Indian Point region).

Given that shortnose sturgeon are known to actively seek out cooler waters when temperatures rise to 28°C (82.4°F), any shortnose sturgeon encountering bottom waters with temperatures above 28°C (82.4°F) area are likely to avoid it. Reactions to this elevated temperature are expected to be limited to swimming away from the plume by swimming around it. Given the extremely small percentage of the estuary that may have temperatures elevated above 28°C (82.4°F) and the limited spatial and temporal extent of any elevations of bottom water temperatures above 28°C (82.4°F), it is extremely unlikely that these minor changes in behavior will preclude shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

Water temperature and dissolved oxygen levels are related, with warmer water generally holding less dissolved oxygen. As such, NMFS has considered the potential for the discharge of heated effluent to affect dissolved oxygen in the action area. Entergy provided an assessment of dissolved oxygen conditions in the vicinity of the thermal plume and nearby downstream areas. Swanson examined dissolved oxygen concentrations observed among 14 recent years (1997 through 2010) of water quality samples taken 0.3 m (1 ft) above the river bottom weekly during the Utilities Fall Shoals surveys in the Indian Point region of the Hudson River from March through November of each year. Only 17 (0.91%) dissolved oxygen concentrations below 5 mg/l were observed in the Indian Point region during this 14-year period consisting of 1,877 readings, and the lowest dissolved oxygen concentration of 3.4 mg/l occurred just once, while the remaining 16 values were between 4.4 mg/l and 4.9 mg/l. Although I/FS survey water quality sampling did not occur in the Indian Point region during the winter period from December through February of each year due to river ice conditions, it is unlikely that dissolved oxygen concentrations below 5 mg/l would be observed then due to the high oxygen saturation of the cold water in the winter. The Hudson River region south of the Indian Point region had 501 dissolved oxygen concentrations below 5 mg/l (6.33% of 7,918 total observations) in the near bottom waters, seven times more frequently than the Indian Point region. Based on this information the discharge of heated effluent appears to have no discernible effect on dissolved oxygen levels in the area. As the thermal plume is not contributing to reductions in dissolved oxygen levels, it will not cause changes in dissolved oxygen levels that could affect any shortnose sturgeon.

Effect on Shortnose Sturgeon Prey

Shortnose sturgeon feed primarily on benthic invertebrates; these prey species are found on the bottom. As explained above, the IP thermal plume is largely a surface plume with elevated temperatures near the bottom limited to short duration and a geographic area limited to the area close to the discharge point. No analysis specific to effects of the thermal plume on the macroinvertebrate community has been conducted. However, given what is known about the plume (i.e., that it is largely a surface plume and has limited effects on water temperatures at or near the bottom) and the areas where shortnose sturgeon forage items are found (i.e., on the bottom), it is unlikely that potential shortnose sturgeon forage items would be exposed to the effects of the thermal plume. If the thermal plume is affecting benthic invertebrates, the most likely effect would be to limit their distribution to areas where bottom water temperatures are not affected by the thermal plume. Considering that shortnose sturgeon are also likely to be excluded from areas where the thermal plume influences bottom water temperatures and given that those areas are small, foraging shortnose sturgeon are not likely to be affected by any limits on the distribution of benthic invertebrates caused by the thermal plume's limited influence on bottom waters. Thus, based on this analysis, it appears that the prey of shortnose sturgeon, would be impacted insignificantly, if at all, by the thermal discharge from IP.

Potential Discharge of Radionuclides to the Hudson River

Environmental monitoring and surveillance for radionuclides have been conducted at IP2 and IP3 since 1958, 4 years before the startup of IP1. The preoperational program was designed and implemented to determine the background radioactivity and to measure the variations in activity levels from natural and other sources in the vicinity, as well as fallout from nuclear weapons tests. The preoperational radiological data include both natural and manmade sources of environmental radioactivity. These background environmental data permit the detection and assessment of current levels of environmental activity attributable to plant operations.

The annual REMP is carried out by Entergy to monitor and document radiological impacts to the environment and the public around the IP2 and IP3 site and compare these to NRC standards. Radionuclides monitored include tritium (^{3}H), strontium-90 (^{90}Sr), nickel-63, and cesium-137. Entergy summarizes the results of its REMP in an Annual Radiological Environmental Operating Report. The objectives of the IP2 and IP3 REMPs are the following: (1) to enable the identification and quantification of changes in the radioactivity of the area; and, (2) to measure radionuclide concentrations in the environment attributable to operations of the IP2 and IP3 site (NRC 2010).

The REMP at IP2 and IP3 directs Entergy to sample environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The REMP designates sampling locations for the collection of environmental media for analysis. These sampling locations are divided into indicator and control locations. Indicator locations are established near the site, where the presence of radioactivity of plant origin is most likely to be detected. Control locations are established farther away (and upwind/upstream, where applicable) from the site, where the level would not generally be affected by plant discharges or effluents. The use of indicator and control locations enables the identification of potential sources of detected radioactivity as either background or from plant operations. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents. The REMP is used to measure the direct radiation and the airborne and waterborne pathway activity in the vicinity of the IP2 and IP3 site. Direct radiation pathways include radiation from buildings and plant structures, airborne material that may be released from the plant, or from cosmic radiation, fallout, and the naturally occurring radioactive materials in soil, air, and water. The liquid waste processing system at IP2 and IP3 collects, holds, treats, processes, and monitors all liquid radioactive wastes for reuse or disposal. During normal plant operations the system receives input from numerous sources, such as equipment drains and leak lines, chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak lines, and floor drains. After it is determined that the amount of radioactivity in the wastewater is diminished to acceptable levels, the water is released into the Hudson River.

Entergy has also identified the migration of tritium to the Hudson River through groundwater pathways. In 2005, Entergy discovered a spent fuel pool water leak to groundwater while installing a new crane to facilitate transfer of Unit 2 spent fuel to dry cask storage. This leak was determined to have generated a groundwater plume of tritium (^{3}H). During efforts to track the ^{3}H plume, ^{90}Sr was discovered in a downgradient portion of the plume and traced back to a leak in the Unit 1 spent fuel pool (Skinner and Sinnott 2009). Because site groundwater flows to the Hudson River, the 2006 Radiological Environmental Monitoring Program (REMP) conducted by Entergy was modified to include ^{90}Sr as an analyte in fish samples. ^{90}Sr was detected in 4 of 10 samples of fish taken from the river in the vicinity of the Indian Point facility, and in three of five samples from an upstream reference location near the Roseton Generating Station in Newburgh, NY. The tissues analyzed were composites of edible flesh from fish representing several species. Entergy concluded that the ^{90}Sr levels were low and may be indistinguishable from background levels from fallout from nuclear weapons testing in the 1950's and 1960's (Entergy 2007). The New York State Departments of Health (NYSDOH) and NYSDEC concurred with Entergy's assessment. However, the NYSDEC and NYSDOH were concerned that the home ranges of several sampled species, and all striped bass, may overlap at the two sampling sites (Skinner and Sinnott 2009). In order to assure independence of sampling sites, the NY agencies initiated a one-time enhanced radiological surveillance for 2007 (results presented in Skinner and Sinnott 2009). The objectives of the enhanced radiological monitoring effort were to: gain information about the levels, impacts, and possible 90Sr sources at the reference locations and the indicator station; determine if significant spatial differences in 90Sr concentrations were present; to assess whether or not 90Sr concentrations in the bones and flesh of fish signify heightened risk either to aquatic life in the Hudson River; and, provide information for an independent assessment of potential public health impacts.

The one-time design modifications for the 2007 effort included: the addition of carp (*Cyprinus carpio*) – a benthic feeder – to the target species list; adding ^{90}Sr to the list of radionuclide analytes; analysis of fish bone or crab carapace; and , sampling fish at a third location, the Catskill Region between river miles 107 and 125. The NY agencies stated that this upstream location assures appropriate separation of fish populations that are resident to the river, and, consequently, assures isolation of resident fish populations from the potential influence of discharges from the Indian Point facility.

The study concluded that there were no apparent excursions above criteria for the protection of biota based on the radionuclide data available. The levels of radionuclides, including ^{90}Sr, were two to five orders of magnitude lower than criteria established by the US Department of Energy (USDOE 2002) for the protection of aquatic animals and freshwater ecosystems. Also, the study concluded that there were no spatial differences in concentrations of ^{90}Sr and ^{224}Ra in resident fish from the three locations sampled in the lower Hudson River (i.e., Indian Point facility, and the reference sites at the Roseton Generating Station and at Catskill). In contrast, ^{40}K levels were somewhat greater in the vicinity of Roseton Generating Station, but the differing concentrations have no known significance.

Detailed information on the radiological investigations, including groundwater, is available in the 2006-2010 REMPs. NRC summarized available data in the FSEIS and also reviewed the 2010 REMP during the consultation period. NRC indicates in the FSEIS that this multi-year period provides a representative data set that covers a broad range of activities that occur at IP2 and IP3 such as, refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities, and that effects during an extended operating period would be consistent with these sampling periods. In the FSEIS, NRC reports that tritium releases in total (groundwater as well as routine liquid effluent) represent less than 0.001% of the Federal dose limits for radioactive effluents from the site. In addition to monitoring potential effects to human health from exposure to radiation, Entergy conducts inspections of radionuclides in the environment, including fish and river sediments.

NRC has reported to NMFS that NRC has reviewed all of the available information on radionuclides and has identified no unusual trends or significant radiological impacts to the environment, including Hudson River water, river sediments and fish tissues, due to operation of the Indian Point facility. In the FSEIS, NRC states that no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations. NRC also summarizes a 2007 NYSDEC report which concludes that strontium-90 levels in fish near the site (18.8 pCi/kg (0.69 Bq/kg)) are no higher than in those fish collected from background locations across New York State.

As explained above, additional information on potential impacts of radionuclides potentially originating from the Indian Point facility on aquatic organisms in the Hudson River is available in a recent report prepared by NYDEC (Skinner and Sinnott 2009). Neither the Skinner and Sinnott report or any of the REMPs identified radionuclide levels attributable to operation of the Indian Point facility that are at levels that are thought to negatively impact fish. It is important to note that no shortnose sturgeon have been tested to determine levels of radionuclides; however, as other species that have been sampled that are similarly mobile through the Hudson River have not indicated that they have radionuclide levels of concern and because expert review (NRC and NYDEC) of environmental indicators (Hudson River water, sediments, aquatic organisms) also indicates that radionuclides originating from the Hudson River, are not at levels of concern. Based on this information, while shortnose sturgeon may be exposed to radionuclides originating from Indian Point, as well as other sources, any exposure is not likely to be at levels that would affect the health or fitness of any individual shortnose sturgeon. Thus, NMFS considers the effects to shortnose sturgeon from radionuclides to be insignificant and discountable.

Other Pollutants Discharged from IP2 and IP3

The 1987 SPDES permit contains effluent limits related to an on-site sewage treatment plant, as well as cooling water discharges. The on-site sewage treatment plant is no longer operational and sanitary waste from Indian Point is now routed to the community wastewater treatment plant. Therefore, no sanitary waste discharges at the Indian Point outfalls will occur during the extended operating period. Other than the pollutants associated with sanitary wastes, pollutants limited by the 1987 SPDES permit include: total residual chlorine (TRC), lithium hydroxide, boron, pH, total suspended solids (TSS), and, oil and grease.

NMFS has no information on the actual levels of these pollutants discharged in the past. NMFS assumes, for the purposes of this analysis, that discharges from Indian Point will be in compliance with the pollutant limits included in the 1987 SPDES permit. The effect of discharges in compliance with these limits on shortnose sturgeon is discussed below.

Total Residual Chlorine

TRC is limited at a maximum daily average of 0.2mg/l. This level of chlorine is measured in the plant, prior to dilution in the Hudson River. Once the waste stream mixes with the Hudson River, concentrations of TRC will be a maximum of 0.019 mg/l (for one hour) and 0.011mg/l (indefinitely).

To date, the effects of TRC on shortnose sturgeon have not been studied; however, there have been a number of studies that have examined the effects of levels of TRC on various fish species (Post 1987; Buckley 1976), including a recent study done on the white sturgeon (Campbell and Davidson 2007). Campbell and Davidson (2007) found that at concentrations of 0.034-0.042 mg/l of chlorine over four days, 50% of the test population, which consisted of 30 day old and 160 day old early life stage and juvenile sturgeon, died (i.e., 96 hour LC50). Similarly, adverse effects to rainbow trout (e.g., reductions of hemoglobin and hemocrit levels indicative of anemia) were found to occur at TRC levels of approximately 0.03 -0.04 mg/L (Buckley 1976; Black and McCarthy 1990). In a study conducted by Dwyer et al. (2000a), researchers compared toxicity test results for a range of species tested, including shortnose and Atlantic sturgeon. While TRC was not one of the compounds tested, the authors concluded that toxicity test results for rainbow trout were a good surrogate for effects to listed fish species, including shortnose sturgeon. As such, while recognizing that these conclusions are based on a limited number of chemical exposures, if rainbow trout can be considered a reasonable surrogate for toxicity testing for shortnose sturgeon, and TRC levels of 0.03-0.04mg/l have been shown to cause adverse affects to rainbow trout, it is reasonable to conclude that shortnose sturgeon would also experience adverse effects if exposed to TRC levels of 0.03-0.04mg/l. The concentration of TRC authorized by the SPDES permit (0.011mg/l in the river) is below the levels shown to adversely affect fish. As such, NMFS anticipates that any effects to shortnose sturgeon from exposure to TRC at concentrations authorized by the SPDES permit would be insignificant and discountable.

Lithium hydroxide

The 1987 SPDES permit authorizes the discharge of lithium hydroxide at a daily maximum concentration of 0.01mg/l. Limited information is available on the toxicity of lithium hydroxide to aquatic species. The no effect concentration level for fish is reported at 13mg/l as determined by exposure of fathead minnows; no effect concentration levels for Daphnia magna are reported at 11mg/l (Long et al. 1997). While no studies have examined the effects of lithium exposure to shortnose sturgeon, as the levels of lithium authorized by the SPDES permit are lower than the levels shown to have no effects to fathead minnows, which are typically used as a surrogate species for other fish in toxicity testing, NMFS anticipates that any effects to shortnose sturgeon from exposure to boron at concentrations authorized by the SPDES permit would be insignificant and discountable.

Boron

The 1987 SPDES permit authorizes the discharge of boron at monthly average concentrations of 1.0mg/l. Chronic toxicity studies with *Daphnia magna* indicate no effect concentration (NOEC) levels ranging between 6 and 10 mg boron/litre (IPCS 1998). A 28-day laboratory study consisting of six trophic stages yielded a NOEC of 2.5 mg boron/litre. Acute tests with several fish species yielded toxicity values ranging from about 10 to nearly 300 mg boron/litre. Rainbow trout (*Oncorhynchus mykiss*) and zebra fish (*Brachydanio rerio*) were the most sensitive, providing values around 10 mg boron/litre (IPCS 1998). While no studies have examined the effects of boron exposure to shortnose sturgeon, as the levels of boron authorized by the SPDES permit are lower than the levels shown to have no effects to a variety of fish species, NMFS anticipates that any effects to shortnose sturgeon from exposure to boron at concentrations authorized by the SPDES permit would be insignificant and discountable.

pH

The permit requires that the discharge maintain a pH of 6.0 – 9.0. This pH is within the normal range of pH for river water. As such, any change in the pH of the receiving water due to the discharge from Indian Point is not expected to deviate significantly from the receiving waters pH and will remain within the normal range for river water that is known to be harmless to aquatic life. Therefore, any effects to shortnose sturgeon will be discountable.

Total Suspended Solids

The 1987 SPDES permit limits the discharge of TSS to a daily maximum of 50mg/l and a monthly average of 30mg/L. TSS can affect aquatic life directly by killing them or reducing growth rate or resistance to disease, by preventing the successful development of fish eggs and larvae, by modifying natural movements and migration, and by reducing the abundance of available food (EPA 1976). These effects are caused by TSS decreasing light penetration and by burial of the benthos. Eggs and larvae are most vulnerable to increases in solids. Due to the distance from the spawning site, neither shortnose sturgeon eggs or larvae are likely to occur in the vicinity of the discharge.

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580mg/L to 700,000mg/L depending on species. Sublethal effects have been observed at substantially lower turbidity levels. For example, prey consumption was significantly lower for striped bass larvae tested at concentrations of 200 and 500 mg/L compared to larvae exposed to 0 and 75 mg/L (Breitburg 1988 in Burton 1993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993). While there have been no directed studies on the effects of TSS on shortnose sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water and Dadswell (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass.

No adverse effects to juvenile or adult fish have been documented at levels at or below 50mg/L (above the highest level authorized by this permit). Based on this information, it is likely that the discharge of TSS in the concentrations authorized by the permit will have an insignificant effect on shortnose sturgeon.

Oil and Grease
High concentrations of petroleum products such as oil and grease can be toxic to aquatic life, including shortnose sturgeon. EPA (1976) indicates that lethal levels of gasoline for finfish are 91mg/L and for waste oil are 1700mg/L. No information is available on the toxic levels of petroleum products on shortnose sturgeon specifically. The limits in the SPDES permit (15mg/L monthly average) is well below the limits demonstrated to cause effects to fish. In addition, as the permit prohibits the discharge of levels of oil and grease at levels that are visible, levels are not likely to reach those where there is a risk of coating. As such, the effect of any exposure of shortnose sturgeon to oil and grease discharged at levels in compliance with the SPDES permit will be insignificant and discountable.

The permit also contains criteria for the thermal plume. Effects of the thermal discharge are considered above. The 1987 SPDES permit also directs Entergy to comply with the biological sampling requirements of the HRSA. These include sampling surveys conducted throughout the Hudson River. These surveys result in the capture of shortnose sturgeon; however, capture and handling of shortnose sturgeon during these studies is authorized by NMFS through the ESA Section 10 scientific research permit discussed above (currently permit #1580, originally issued as #1254). As such, effects of these studies will not be considered further in this Opinion.

CUMULATIVE EFFECTS
Cumulative effects as defined in 50 CFR 402.02 to include the effects of future State, tribal, local or private actions that are reasonably certain to occur within the action area considered in the biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. Ongoing Federal actions are considered in the Status of the Species/Environmental Baseline section above. The effects of ongoing actions that occur in the Hudson River, but outside the action area (e.g., other power plants), are discussed in the Status of the Species/Environmental Baseline section above.

Sources of human-induced mortality, injury, and/or harassment of shortnose sturgeon resulting from future State, tribal, local or private actions in the action area that are reasonably certain to occur in the future include incidental takes in state-regulated fishing activities, pollution, global climate change, research activities and, coastal development. While the combination of these activities may affect shortnose sturgeon, preventing or slowing the species' recovery, the magnitude of these effects in the action area is currently unknown. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the status of the species/environmental baseline section.

State Water Fisheries - Future recreational and commercial fishing activities in state waters may take shortnose sturgeon. In the past, it was estimated that up to 100 shortnose sturgeon were captured in shad fisheries in the Hudson River each year, with an unknown mortality rate. In 2009, NY State closed the shad fishery indefinitely. That state action is considered to benefit for shortnose sturgeon. Should the shad fishery reopen, shortnose sturgeon would be exposed to the risk of interactions with this fishery. However, NMFS has no indication that reopening the fishery and any effects from it on shortnose sturgeon are reasonably certain to occur. Information on interactions with shortnose sturgeon for other fisheries operating in the action area is not available and it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Status of the Species/Environmental Baseline section. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the status of the species/environmental baseline section.

Pollution and Contaminants – Human activities in the action area causing pollution are reasonably certain to continue in the future, as are impacts from them on shortnose sturgeon. However, the level of impacts cannot be projected. Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the status of the species/environmental baseline section.

If there is any action by the State of New York regarding the Section 401 Certificate and SPDES permit, such action would constitute the type of future state action in the action area considered in the cumulative effects section. As discussed above, whether NYDEC will reverse its denial of a Section 401Water Quality Certification and issue a new SPDES permit for the Indian Point facility is not reasonably certain to occur; therefore, the effects of any reversal and new SPDES permit are also not reasonably certain and it is not clear to what extent these future activities would affect shortnose sturgeon.

In the future, *global climate change* is expected to continue and may impact shortnose sturgeon and their habitat in the action area. However, as noted in the ―Status of the Species/Environmental Baseline" section above, given the likely rate of change associated with climate impacts (i.e., the century scale), it is unlikely that climate related impacts will have a significant effect on the status of shortnose sturgeon over the temporal scale of the proposed action (i.e., from September 2013 to September 2033 (IP2) and December 2015 through December 2035 (IP3)) or that in this time period, the abundance, distribution, or behavior of these species in the action area will change as a result of climate change related impacts. The greatest potential for climate change to impact NMFS assessment would be if ambient water temperatures increased enough such that the thermal plume caused a larger area of the Hudson River to have temperatures that were stressful or lethal to shortnose sturgeon. In the 2000s, the mean Hudson river water temperature, as measured at the Poughkeepsie Water Treatment

Facility, was approximately 2°C higher than averages recorded in the 1960s (Pisces 2008). However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Hudson River generally. Assuming that the water temperatures in the river increased at the same rate over the next 40 years, one could anticipate a 1°C increase over the proposed 20 year operating period. Given this small increase, it is not reasonably certain that over the proposed 20-year operating period that any water temperature changes would be significant enough to affect the conclusions reached by NMFS above.

INTEGRATION AND SYNTHESIS OF EFFECTS

NMFS has estimated that the proposed continued operation of IP2 and IP3 through the extended license period (September 2013 through September 2033 and December 2015 through December 2035, respectively) will result in the impingement of up to 6 shortnose sturgeon at IP1, 104 shortnose sturgeon at IP2, and 58 shortnose sturgeon at IP3. As explained in the ―Effects of the Action" section, all other effects to shortnose sturgeon, including to their prey and from the discharge of heat, will be insignificant or discountable.

In the discussion below, NMFS considers whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of shortnose sturgeon. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of shortnose sturgeon. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, ―the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined as, ―improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Below, for shortnose sturgeon, the listed species that may be affected by the proposed action, NMFS summarizes the status of the species and considers whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of that species, as those terms are defined for purposes of the federal Endangered Species Act.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and

Hudson Rivers. As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

The Hudson River population of shortnose sturgeon is the largest in the United States. Historical estimates of the size of the population are not available as historic records of sturgeon in the river did not discriminate between Atlantic and shortnose sturgeon. Population estimates made by Dovel et al. (1992) based on studies from 1975-1980 indicated a population of 13,844 adults. Bain et al. (1998) studied shortnose sturgeon in the river from 1993-1997 and calculated an adult population size of 56,708 with a 95% confidence interval ranging from 50,862 to 64,072 adults. Bain determined that based on sampling effort and methodology his estimate is directly comparable to the population estimate made by Dovel et al. Bain concludes that the population of shortnose sturgeon in the Hudson River in the 1990s was 4 times larger than in the late 1970s. Bain states that as his estimate is directly comparable to the estimate made by Dovel, this increase is a ―confident measure of the change in population size.” Bain concludes that the Hudson River population is large, healthy and particular in habitat use and migratory behavior. Woodland and Secor (2007) conducted studies to determine the cause of the increase in population size. Woodland and Secor captured 554 shortnose sturgeon in the Hudson River and made age estimates of these fish. They then hindcast year class strengths and corrected for gear selectivity and cumulative mortality. The results of this study indicated that there was a period of high recruitment (31,000 – 52,000 yearlings) in the period 1986-1992 which was preceded and succeeded by 5 years of lower recruitment (6,000 – 17,500 yearlings/year). Woodland and Secor reports that there was a 10-fold recruitment variability (as measured by the number of yearlings produced) over the 20-year period from the late 1970s to late 1990s and that this pattern is expected in a species, such as shortnose sturgeon, with periodic life history characterized by delayed maturation, high fecundity and iteroparous spawning, as well as when there is variability in interannual hydrological conditions. Woodland and Secor examined environmental conditions throughout this 20-year period and determined that years in which water temperatures drop quickly in the fall and flow increases rapidly in the fall (particularly October), are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults.

The Hudson River population of shortnose sturgeon has exhibited tremendous growth in the 20-year period between the late 1970s and late 1990s. Woodland and Secor conclude that this is a robust population with no gaps in age structure. Lower recruitment that followed the 1986-1992 period is coincident with record high abundance suggesting that the population may be reaching carrying capacity. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, add uncertainty to any determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is at best stable, with gains in populations such as the Hudson, Delaware and Kennebec offsetting the continued decline of southern river populations, and at worst declining.

As described in the Status of the Species/Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the action area are affected by impingement at water intakes, habitat alteration, bycatch in commercial and recreational fisheries, water quality and in-water construction activities. It is difficult to quantify the number of shortnose sturgeon that may be killed in the Hudson River each year due to anthropogenic sources. Through reporting requirements implemented under Section 7 and Section 10 of the ESA, for specific actions NMFS obtains some information on the number of incidental and directed takes of shortnose sturgeon each year. Typically, scientific research results in the capture and collection of less than 100 shortnose sturgeon in the Hudson River each year, with little if any mortality. NMFS has no reports of interactions or mortalities of shortnose sturgeon in the Hudson River resulting from dredging or other in-water construction activities. NMFS also has no quantifiable information on the effects of habitat alteration or water quality; in general, water quality has improved in the Hudson River since the 1970s when the CWA was implemented. NMFS also has anecdotal evidence that shortnose sturgeon are expanding their range in the Hudson River and fully utilizing the river from the Manhattan area upstream to the Troy Dam, which suggests that the movement and distribution of shortnose sturgeon in the river is not limited by habitat or water quality impairments. Impingement at the Roseton and Danskammer plants is regularly reported to NMFS. Since reporting requirements were implemented in 2000, less than the exempted number of takes (6 total for the two facilities) have occurred each year. Despite these ongoing threats, there is evidence that the Hudson River population of shortnose sturgeon experienced tremendous growth between the 1970s and 1990s and that the population is now stable at high numbers. Shortnose sturgeon in the Hudson River continue to experience anthropogenic and natural sources of mortality. However, NMFS is not aware of any future actions that are reasonably certain to occur that are likely to change this trend or reduce the stability of the Hudson River population. Also, as discussed above, NMFS does not expect shortnose sturgeon to experience any new effects associated with climate change during the 20-year duration of the proposed action. As such, NMFS expects that numbers of shortnose sturgeon in the action area will continue to be stable at high levels over the 20-year duration of the proposed action.

NMFS has estimated that the proposed continued operation of IP2 and IP3 through the extended license period (September 2013 through September 2033 and December 2015 through December 2035, respectively) will result in the impingement of up to 6 shortnose sturgeon at the IP1 intake (to be used for service water for IP2), 104 shortnose sturgeon at IP2 and 58 shortnose sturgeon at IP3, all of which may die as a result of their impingement. This number represents a very small percentage of the shortnose sturgeon population in the Hudson River, which is believed to be stable, and an even smaller percentage of the total population of shortnose sturgeon rangewide.

The best available population estimates indicate that there are approximately 56,708 (95% CI=50,862 to 64,072) adult shortnose sturgeon in the Hudson River and an unknown number of juveniles (ERC 2006). While the death of up to 168 shortnose sturgeon over a 20-year period will reduce the number of shortnose sturgeon in the population compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population or its stable trend as this loss represents a very small percentage of the population (less than 0.30%).

Reproductive potential of the Hudson population is not expected to be affected in any other way other than through a reduction in numbers of individuals. A reduction in the number of shortnose sturgeon in the Hudson River would have the effect of reducing the amount of potential reproduction in this system as the fish killed would have no potential for future reproduction. However, it is estimated that on average, approximately 1/3 of adult females spawn in a particular year and approximately ½ of males spawn in a particular year. Given that the best available estimates indicate that there are more than 56,000 adult shortnose sturgeon in the Hudson River, it is reasonable to expect that there are at least 20,000 adults spawning in a particular year. It is unlikely that the loss of 168 shortnose sturgeon over a 20-year period would affect the success of spawning in any year. Additionally, this small reduction in potential spawners is expected to result in a small reduction in the number of eggs laid or larvae produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individuals that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be very small and would not change the stable trend of this population. Additionally, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

The proposed action is not likely to reduce distribution because the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Hudson River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Additionally, as the number of shortnose sturgeon likely to be killed as a result of the proposed action is less than 0.30% of the Hudson River population, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species can have an appreciable effect on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity (see status of the species/environmental baseline section above), and there are thousands of shortnose sturgeon spawning each year.

Based on the information provided above, the death of up to 168 shortnose sturgeon over a 20-year period resulting from the proposed continued operation of IP2 and IP3 under renewed licenses for the period September 2013 through September 2033 (IP2) and December 2015 through December 2035 (IP3) will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) the population trend of shortnose sturgeon in the Hudson River is stable; (2) the death of up to 168 shortnose sturgeon represents an extremely small percentage of the number of shortnose sturgeon in the Hudson River and a even smaller percentage of the species as a whole; (3) the loss of these shortnose sturgeon is likely to have such a small effect on reproductive output of the Hudson River population of shortnose sturgeon or the species as a whole that the loss of these shortnose sturgeon will not change the status or trends of the Hudson River population or the species as a whole; (4) and, the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area (related to movements around the thermal plume) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival but might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild. Here, NMFS considers the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., ―endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., ―threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in a small reduction in the number of shortnose sturgeon in the Hudson River and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is likely to result in the mortality of up to 168 shortnose sturgeon; however, over the 20-year period, the loss of these individuals and what would have been their progeny is not expected to affect the persistence of the Hudson River population of shortnose sturgeon or the species as a whole. The loss of these individuals will not change the status or trend of the Hudson River population, which is stable at high numbers. As it will not affect the status or trend of this population, it will not affect the status or trend of the species as a whole. As the reduction in numbers and future reproduction is very small, this loss would not result in an appreciable reduction in the likelihood of improvement in the status of shortnose sturgeon throughout their range. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only a small percentage of the shortnose sturgeon in the Hudson River and an even smaller percentage of the species as a whole and these mortalities are not expected to result in the reduction of overall reproductive fitness for the species as a whole. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than 168 shortnose sturgeon over the 20-year period of the proposed renewed licenses is not likely to appreciably reduce the survival and recovery of this species.

CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the proposed action, interdependent and interrelated actions and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon. No critical habitat is designated in the action area; therefore, none will be affected by the proposed action.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. ―Fish and wildlife" is defined in the ESA ―as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, nonmigratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof." 16 U.S.C. 1532(8). ―Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. ―Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person ―to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]" 16 U.S.C. 1538(g). See also 16 U.S.C. 1532(13)(definition of ―person"). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by NRC so that they become binding conditions for the exemption in section 7(o)(2) to apply. NRC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NRC (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant, Entergy, to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the renewed license, the protective coverage of section

7(o)(2) may lapse. In order to monitor the impact of incidental take, NRC or the applicant must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

Amount or Extent of Take

Pursuant to the terms of the proposed extended operating licenses, IP2 and IP3 would continue to operate for an additional 20 years. This ITS applies to the extended operating period, beginning at the date that the facility begins to operate under the terms of a new license and extending through the expiration date of that license. NRC has indicated it is unlikely that any new license would be issued prior to the expiration date of the existing licenses. As such, NMFS anticipates that this amount of take will occur at IP2, from September 28, 2013, until September 28, 2033, and IP3 from December 12, 2015, until December 12, 2035. The exemption from Section 9 prohibitions would apply only during that time period as well. The operation of IP2 and IP3 during the extended operating period will directly affect shortnose sturgeon due to impingement at intakes. These interactions constitute ―capture" or ―collect" in the definition of ―take" and will cause injury and mortality to the affected individuals. Based on the distribution of shortnose sturgeon in the action area and information available on historic interactions between shortnose sturgeon and the IP facility, NMFS has estimated that the proposed action will result in the impingement of up to 6 shortnose sturgeon at the IP1 intake (service water), 104 shortnose sturgeon at IP2 and 58 shortnose sturgeon at IP3 during the 20-year extended operating period. All of these sturgeon are expected to die, immediately or later, as a result of interactions with the facility. As explained in the ―Effects of the Action" section, effects of the facility on shortnose sturgeon also include effects on distribution due to the thermal plume as well as effects to prey items; however, NMFS does not anticipate or exempt any take of shortnose sturgeon due to effects to prey items or due to exposure to the thermal plume. This ITS exempts the following take:

- A total of 6 shortnose sturgeon (dead or alive) impinged at the Unit 1[12] intakes (trash bars or screens) during the period September 28, 2013 – September 28, 2033;
- A total of 104 shortnose sturgeon (dead or alive) impinged at Unit 2 (trash bars or Ristroph screens) during the period September 28, 2013 – September 28, 2033; and,
- A total of 58 shortnose sturgeon (dead or alive) impinged at Unit 3 (trash bars or Ristroph screens) during the period December 12, 2015 – December 12, 2035.

The Section 9 prohibitions against take apply to live individuals as well as to dead specimens and their parts. The Section 9 prohibitions include ―capture" and ―collect" in the definition of take, as well as injury and mortality. NMFS recognizes that shortnose sturgeon that have been killed prior to impingement at the IP facility may become impinged on the intakes at IP1, IP2 and IP3 and that some number of dead shortnose sturgeon taken at the facility may not necessarily have

---

12 As explained in the Opinion, water withdrawn through the Unit 1 intakes is used for service water for the operation of IP2.

been killed by the operation of the facility itself. However, the capture or collection of previously dead animals is prohibited under Section 9 and will be exempted through this ITS. Additionally, NMFS recognizes the potential for some shortnose sturgeon to pass through the trash bars, contact the Ristroph screens and travel down the sluice back to the River without significant injury or mortality. The Section 9 prohibitions on take also apply to the capture or collection of live, uninjured animals even if these animals are released without injury. Thus, it is appropriate for this ITS to also address shortnose sturgeon that may be captured or collected at the Ristroph screens and returned to the river unharmed. As no monitoring has taken place at the intakes, NMFS can not predict what percentage of shortnose sturgeon would be collected at the Ristroph screens without injury or mortality and, therefore, NMFS is not able to refine this estimate of take to separate out the number of fish that may be collected but not killed. Due to the difficulty in determining the cause of death of shortnose sturgeon found dead at the intakes and the lack of past necropsy results that would allow NMFS to better assess the likely cause of death of impinged shortnose sturgeon, the aforementioned anticipated level of take includes shortnose sturgeon that may have been dead prior to impingement on the IP intakes. As explained in the Opinion, NMFS does not have sufficient information to predict what percentage of impinged shortnose sturgeon were previously dead and merely captured or collected at the facility and sturgeon that died as a result of their impingement at the Indian Point intakes. Therefore, NMFS was not able to further refine this estimate of take into a number of previously dead sturgeon captured or collected at the facility and a number of sturgeon whose death was caused by impingement at the facility. In the accompanying Opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to shortnose sturgeon.

Reasonable and Prudent Measures
In order to effectively monitor the effects of this action, it is necessary to monitor the intakes to document the amount of incidental take (i.e., the number of shortnose sturgeon captured, collected, injured or killed) and to examine the shortnose sturgeon that are impinged at the facility. Monitoring provides information on the characteristics of the shortnose sturgeon encountered and may provide data which will help develop more effective measures to avoid future interactions with listed species. NMFS does not anticipate any additional injury or mortality to be caused by removing the fish from the water and examining them as required in the RPMs. Any live sturgeon are to be released back into the river, away from the intakes and thermal plume. These RPMs and their implementing terms and conditions apply to both the license to be issued for the continued operation of IP2 and the license to be issued for the continued operation of IP3.

NMFS believes the following reasonable and prudent measures are necessary or appropriate for NRC and the applicant, Entergy, to minimize and monitor impacts of incidental take of endangered shortnose sturgeon:

1. A program to monitor the incidental take of shortnose sturgeon at the IP1, IP2 and IP3 intakes must be developed, approved by NMFS, and implemented throughout the duration of the extended operating period.

2. All live shortnose sturgeon must be released back into the Hudson River at an appropriate location away from the intakes and thermal plume that minimizes the additional risk of death or injury.

3. Any dead shortnose sturgeon must be transferred to NMFS or an appropriately permitted research facility NMFS will identify so that a necropsy can be undertaken to attempt to determine the cause of death.

4. All shortnose sturgeon impingements associated with the Indian Point facility and any shortnose sturgeon sightings in the action area must be reported to NMFS.

Terms and Conditions
In order to be exempt from prohibitions of section 9 of the ESA, Entergy must comply with, and NRC must ensure through enforceable terms of the renewed license that Entergy does comply with, the following terms and conditions of the Incidental Take Statement, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned (ESA Section 7(o)(2)). Due to the difficulty in visually distinguishing shortnose sturgeon from other sturgeon, to ensure that the incidental take level for shortnose sturgeon is not exceeded, and to guard against misidentifying and not counting fish that are in fact shortnose sturgeon, the terms and conditions below refer to –shortnose sturgeon or fish that might be shortnose sturgeon."

1. To implement RPM #1, Entergy must implement throughout the term of the renewed license an endangered species monitoring plan that has been approved by NMFS and that allows for the detection and observation of all shortnose sturgeon or fish that might be shortnose sturgeon that are impinged anywhere at the intakes, including on the trash bars, or that contact the Ristroph screens. This monitoring plan must be approved by NMFS prior to the effective date of any renewed license and must be implemented beginning on the day that the new license becomes effective. This monitoring plan must contains the following components:
   a. methods and procedure for monitoring the intake trash bars on a schedule that ensures detection and timely release of all shortnose sturgeon or fish that might be shortnose sturgeon impinged on the trash bars;
   b. any method developed to monitor the intake trash bars for shortnose sturgeon or fish that might be shortnose sturgeon must be able to detect all individuals impinged at the trash bars within 24 hours of its impingement;
   c. methods and procedures for monitoring the Ristroph screens on a schedule that ensures detection and timely release of all shortnose sturgeon or fish that might be shortnose sturgeon that pass through the trash bars and contact or are impinged on the screens;
   d. any method developed to monitor the Ristroph screens must ensure the detection and inspection of all shortnose sturgeon or fish that might be a shortnose sturgeon prior to its being discharged back into the River;

e. a handling and release plan that describes how all live shortnose sturgeon or fish that might be shortnose sturgeon that are impinged at the trash bars or the Ristroph screens will be safely removed from the water, handled for examination, and returned to the River;
f. handling and disposal procedures for dead shortnose sturgeon or body parts of shortnose sturgeon or fish that may be shortnose sturgeon;
g. procedures for obtaining genetic samples from all shortnose sturgeon or fish that may be shortnose sturgeon;
h. reporting forms that contain all information to be reported for all incidental takes of shortnose sturgeon or fish that may be shortnose sturgeon;
i. procedures for notifying NMFS of all incidental takes; and,
j. procedures for making any necessary updates or modifications to the monitoring plan.

2. To implement RPM #2, Entergy must ensure that all live shortnose sturgeon or fish that might be shortnose sturgeon are returned to the river away from the intakes and the thermal plume, following complete documentation of the event. Handling and release procedures must be a part of the monitoring plan outlined in Term and Condition #1.

3. To implement RPM #3, Entergy must ensure that all dead specimens or body parts of shortnose sturgeon or fish that might be sturgeon are photographed, measured, and preserved (refrigerate or freeze). No dead shortnose sturgeon or body parts of shortnose sturgeon or fish that might be sturgeon may be disposed without discussing disposal procedures with NMFS. General disposal procedures will be included in the monitoring plan outlined in Term and Condition #1 above. NMFS may request that the specimen be transferred to NMFS or to an appropriately permitted researcher so that a necropsy may be conducted. The form included as Appendix I must be completed and submitted to NMFS as noted above.

4. To implement RPM #4, if any live or dead shortnose sturgeon or fish that might be shortnose sturgeon are taken at IP1, IP2 or IP3, Entergy must notify NMFS (978-281-9328) and NRC immediately. An incident report (Appendix I) must also be completed by plant personnel and sent to the NMFS Section 7 Coordinator via FAX (978-281-9394) within 24 hours of the take. Every shortnose sturgeon, or fish that might be a shortnose sturgeon, must be photographed. Information in Appendix II will assist in identification of a shortnose sturgeon or fish that might be a shortnose sturgeon.

5. To implement RPM #2, Entergy must notify NMFS and NRC in writing when the facility reaches 50% of the incidental take level for shortnose sturgeon. At that time, NMFS will determine if additional measures are necessary or appropriate to minimize impingement at the intake structures or if additional monitoring is necessary.

6. To implement RPM #4, Entergy must submit an annual report of incidental takes to NMFS and NRC by February 15 of each year. The report must include, as detailed in this Incidental Take Statement and the monitoring plan required by Term and Condition #1, any necropsy reports of specimens, incidental take reports, photographs , a record of all

sightings of shortnose sturgeon, or fish that might be a shortnose sturgeon, in the vicinity of Indian Point, and a record of when inspections of the intake trash bars and Ristroph screens were conducted for the 48 hours prior to the take. The annual report must also identify any potential measures to reduce shortnose sturgeon impingement, injury, and mortality at the intake structures. At the time the report is submitted, NMFS will supply NRC and Entergy with any information on changes to reporting requirements (i.e., staff changes, phone or fax numbers, e-mail addresses) for the coming year.

7. To implement RPM #4, Entergy must ensure that fin clips are taken (according to the procedure outlined in Appendix III and as included in the monitoring plan required by Term and Condition #1) of any shortnose sturgeon or fish that might be shortnose sturgeon, and that the fin clips are sent to NMFS for genetic analysis .

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will ensure that Entergy monitors the intakes in a way that allows for the detection of all impinged shortnose sturgeon and implements measures to reduce the potential of mortality for all shortnose sturgeon impinged at Indian Point, to report all interactions to NMFS and NRC and to provide information on the likely cause of death of any shortnose sturgeon impinged at the facility. The discussion below explains why each of these RPMs and Terms and Conditions are necessary or appropriate to minimize or monitor the level of incidental take associated with the proposed action. The RPMs and terms and conditions involve only a minor change to the proposed action.

RPM #1 and Term and Condition #1 are necessary and appropriate because they are specifically designed to ensure that all appropriate measures are carried out to monitor the incidental take of shortnose sturgeon at Indian Point, which by definition includes the capture or collection of live shortnose sturgeon as well as the injury or mortality of impinged shortnose sturgeon. An effective monitoring plan is essential to allow NRC and Entergy to fulfill the requirement to monitor the actual level of incidental take associated with the operation of Indian Point and to allow NMFS and NRC to determine if the level of incidental take is ever exceeded. These requirements are also essential for determining whether the death was related to the operation of the facility. These conditions ensure that the potential for detection of shortnose sturgeon at the intakes is maximized and that any shortnose sturgeon removed from the water are removed in a manner that minimizes the potential for further injury.

RPM#2 and Term and Condition #2 are necessary and appropriate to ensure that any shortnose sturgeon that survive impingement is given the maximum probability of remaining alive and not suffering additional injury or subsequent mortality through inappropriate handling or release near the intakes.

RPM #3 and Terms and Conditions #3 are necessary and appropriate to ensure the proper handling and documentation of any shortnose sturgeon removed from the intakes that are dead or die while in Entergy custody. This is essential for monitoring the level of incidental take associated with the proposed action and in determining whether the death was related to the operation of the facility.

RPM#4 and Term and Condition #4-7 are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as the prompt reporting of these interactions to NMFS. Sampling of fin tissue is used for genetic sampling. This procedure does not harm shortnose sturgeon and is common practice in fisheries science. Tissue sampling does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact. NMFS has received no reports of injury or mortality to any shortnose sturgeon sampled in this way.

CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to ―utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. As such, NMFS recommends that the NRC consider the following Conservation Recommendations:

1. The NRC should use its authorities to ensure tissue analysis of dead shortnose sturgeon removed from the Indian Point intakes is performed to determine contaminant loads, including radionuclides.

2. The NRC should use its authorities to ensure in-water assessments, abundance, and distribution surveys for shortnose sturgeon in the Hudson River, and Haverstraw Bay specifically, are performed.

3. The NRC should use its authorities to ensure studies are performed that document the presence, if any, of shortnose sturgeon in the broadest area affected by the thermal plume in order to validate the assumption in this Opinion that shortnose sturgeon are likely to move away from the thermal plume.

REINITIATION OF CONSULTATION

This concludes formal consultation on the continued operation of IP2 and IP3 for an additional 20 years pursuant to a license proposed for issuance by NRC. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

LITERATURE CITED

Allen PJ, Nicholl M, Cole S, Vlazny A, Cech JJ Jr. 2006. Growth of larval to juvenile green sturgeon in elevated temperature regimes. Trans Am Fish Soc 135:89–96

ASA (Analysis and Communication). 2008. 2006 year class report for the Hudson River Estuary Program prepared for Dynegy Roseton LLC, on behalf of Dynegy Roseton LLC Entergy Nuclear Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, and Mirant Bowline LLC. Washingtonville NY.

Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M., K. Arend, N. Haley, S. Hayes, J. Knight, S. Nack, D. Peterson, and M. Walsh. 1998a. Sturgeon of the Hudson River: Final Report on 1993-1996 Research. Prepared for The Hudson River Foundation by the Department of Natural Resources, Cornell University, Ithaca, New York.

Bain, Mark B., D.L. Peterson, K. K. Arend. 1998b. Population status of shortnose sturgeon in the Hudson River: Final Report. Prepared for Habitat and Protected Resources Division National Marine Fisheries Service by New York Cooperative Fish and Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY.

Bain, Mark B., N. Haley, D. L. Peterson, K. K. Arend, K. E. Mills, P. J. Sullivan. 2000. Annual meeting of American fisheries Society. EPRI-AFS Symposium: Biology, Management and Protection of Sturgeon. St. Louis, MO. 23-24 August 2000.

Bain, Mark B., N. Haley, D. L. Peterson, K. K Arend, K. E. Mills, P. J. Sulivan. 2007. Recovery of a US Endangered Fish. PLoS ONE 2(1): e168. doi:10.1371/journal.pone.0000168

Bath, D.W., J.M. O'Conner, J.B. Albert and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrinchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981:711-717.

Beamesderfer, Raymond C.P. and Ruth A. Farr. 1997. Alternatives for the protection and restoration of sturgeons and their habitat. Environmental Biology of Fishes 48: 407-417.

Berlin, W.H., R.J. Hesselberg, and M.J. Mac. 1981. Chlorinated hydrocarbons as a factor in the reproduction and survival of lake trout (Salvelinus namaycush) in Lake Michigan. Technical Paper 105 of the U.S. Fish and Wildlife Service, 42 pages.

Buckley, J., and B. Kynard. 1981. Spawning and rearing of shortnose sturgeon from the Connecticut River. Progressive Fish Culturist 43:74-76.

Buckley, J. and B. Kynard. 1985. Habitat use and behavior of pre-spawing and spawning shortnose sturgeon, *Acipenser brevirostrum*, in the Connecticut River. North American Sturgeons: 111-117.

Carlson, D.M., and K.W. Simpson. 1987. Gut contents of juvenile shortnose sturgeon in the upper Hudson estuary. Copeia 1987:796-802

CHGE. Central Hudson Gas and Electric Corp., Consolidated Edison Company of New York, New York Power Authority, and Southern Energy New York. 1999. Draft environmental impact statement for State pollution discharge elimination system permits for Bowline Point1&2, Indian Point 1&2, and Roseton 1&2 Steam electric generating stations.

Collins, M. R., S. G. Rogers, and T. I. J. Smith. 1996. Bycatch of sturgeons along the Southern Atlantic Coast of the USA. North American Journal of Fisheries Management 16: 24-29.

Dadswell, M.J. 1979. Biology and population characteristics of the shortnose sturgeon, Acipenser brevirostrum LeSueur 1818 (Osteichthyes: Acipenseridae), in the Saint John River estuary, New Brunswick, Canada. Canadian Journal of Zoology 57:2186-2210.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* Lesueur 1818. NOAA Technical Report, NMFS 14, National Marine Fisheries Service. October 1984 45 pp.

Dovel, W.J. 1978. The Biology and management of shortnose and Atlantic sturgeons of the Hudson River. Performance report for the period April 1, to September 30, 1978. Submitted to N.Y. State Department of Environmental Conservation.

Dovel, W.J. 1979. Biology and management of shortnose and Atlantic sturgeon of the Hudson River. New York State Department of Environmental Conservation, AFS9-R, Albany.

Dovel, W.L. 1981. The Endangered shortnose sturgeon of the Hudson Estuary: Its life history and vulnerability to the activities of man. The Oceanic Society. FERC Contract No. DE-AC 39-79 RC-10074.

Dovel, W.L., A.W. Pekovitch, and T.J. Berggren. 1992. Biology of the shortnose sturgeon (*Acipenser brevirostrum* Lesueur 1818) in the Hudson River estuary, New York. Pages 187-216 in C.L. Smith (editor). Estuarine research in the 1980s. State University of New York Press, Albany, New York.

Dwyer, F. James, Douglas K. Hardesty, Christopher G. Ingersoll, James L. Kunz, and David W. Whites. 2000. Assessing contaminant sensitivity of American shad, Atlantic sturgeon, and shortnose sturgeon. Final Report. U.S. Geological Survey. Columbia Environmental Research Center, 4200 New Have Road, Columbia, Missouri.

Entergy Nuclear Operations, Inc. (Entergy). 2007a. ―Indian Point, Units 2 & 3, License Renewal Application." April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. ―Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to ―Indian Point, Units 2 & 3, License Renewal Application".) April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from Fred Dacimo, Indian Point Energy Center Site Vice President, to the U.S. NRC regarding Indian Point Nuclear Generating Units Nos. 2 and 3. Docket Nos. 50-247, 50-286. May 3, 2007.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2002. Contaminant analysis of tissues from two shortnose sturgeon (Acipenser brevirostrum) collected in the Delaware River. Prepared for National Marine Fisheries Service. 16 pp. + appendices.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2007. Preliminary acoustic tracking study of juvenile shortnose sturgeon and Atlantic sturgeon in the Delaware River. May 2006 through March 2007. Prepared for NOAA Fisheries. 9 pp.

Eyler, Sheila M., Jorgen E. Skjeveland, Michael F. Mangold, and Stuart A. Welsh. 2000. Distribution of Sturgeons in Candidate Open Water Dredged Material Placement Sites in the Potomac River (1998-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 26 pp.

Fernandes, S.J. 2008. Population demography, distribution, and movement patterns of Atlantic and shortnose sturgeons in the Penobscot River estuary, Maine. University of Maine. Masters thesis. 88 pp.

Flournoy, P.H., S.G. Rogers, and P.S. Crawford. 1992. Restoration of shortnose sturgeon in the Altamaha River, Georgia. Final Report to the U.S. Fish and Wildlife Service, Atlanta, Georgia.

Geoghegan, P., M.T. Mattson and R.G Keppel. 1992. Distribution of shortnose sturgeon in the Hudson River, 1984-1988. IN Estuarine Research in the 1980s, C. Lavett Smith, Editor. Hudson River Environmental Society, Seventh symposium on Hudson River ecology. State University of New York Press, Albany NY, USA.

Giesy, J.P., J. Newsted, and D.L. Garling. 1986. Relationships between chlorinated hydrocarbon concentrations and rearing mortality of chinook salmon (Oncorhynchus tshawytscha) eggs from Lake Michigan. Journal of Great Lakes Research 12(1):82-98.

Gilbert, C.R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82, 28 pages.

Grunwald, C., J. Stabile, J.R. Waldman, R. Gross, and I. Wirgin. 2002. Population genetics of shortnose *sturgeon (Acipenser brevirostrum*) based on mitochondrial DNA control region sequences. Molecular Ecology 11: 000-000.

Hansen, P.D. 1985. Chlorinated hydrocarbons and hatching success in Baltic herring spring spawners. Marine Environmental Research 15:59-76.

Haley, N. 1996. Juvenile sturgeon use in the Hudson River Estuary. Master's thesis. University of Massachusetts, Amhearst, MA, USA.

Hall, W.J., T.I.J. Smith, and S.D. Lamprecht. 1991. Movements and habitats of shortnose sturgeon Acipenser brevirostrum in the Savannah River. Copeia (3):695-702.

Hastings, R.W. 1983. A study of the shortnose sturgeon (*Acipenser brevirostrum*) population in the upper tidal Delaware River: Assessment of impacts of maintenance dredging. Final Report to the U.S. Army Corps of Engineers, Philadelphia, Pennsylvania. 129 pp.

Heidt, A.R., and R.J. Gilbert. 1978. The shortnose sturgeon in the Altamaha River drainage, Georgia. Pages 54-60 in R.R. Odum and L. Landers, editors. Proceedings of the rare and endangered wildlife symposium. Georgia Department of Natural Resources, Game and Fish Division, Technical Bulletin WL 4, Athens, Georgia.

Holland, B.F., Jr. and G.F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources, Division of Commercial and Sports Fisheries, Morehead City. Special Scientific Report 24:1-132.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43: 617-627.IPCC (Intergovernmental Panel on Climate Change) 2007. Fourth Assessment Report. Valencia, Spain.

Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1993. Tolerance of shortnose sturgeon, *Acipenser brevirostrum*, juveniles to different salinity and dissolved oxygen concentrations. Proceedings of the Southeast Association of Fish and Wildlife Agencies, Atlanta, Georgia.

Kieffer, M.C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 1221: 1088-1103.

Kieffer, M., and B. Kynard. 1996. Spawning of shortnose sturgeon in the Merrimack River. Transactions of the American Fisheries Society 125:179-186.

Kieffer and Kynard in review [book to be published by AFS]. Kieffer, M. C., and B. Kynard. In review. Pre-spawning and non-spawning spring migrations, spawning, and effects of hydroelectric dam operation and river regulation on spawning of Connecticut River shortnose sturgeon.

Kocan, R.M., M.B. Matta, and S. Salazar. 1993. A laboratory evaluation of Connecticut River coal tar toxicity to shortnose sturgeon (*Acipenser brevirostrum)* embryos and larvae. Final Report to the National Oceanic and Atmospheric Administration, Seattle, Washington.

Kynard, B. 1996. Twenty-one years of passing shortnose sturgeon in fish lifts on the Connecticut River: what has been learned? Draft report by National Biological Service, Conte Anadromous Fish Research Center, Turners Falls, MA. 19 pp.

Kynard, B. 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon, Acipenser brevirostrum. Environmental Biology of Fishes 48:319–334.

Longwell, A.C., S. Chang, A. Hebert, J. Hughes and D. Perry. 1992. Pollution and developmental abnormalities of Atlantic fishes. Environmental Biology of Fishes 35:1- 21.

Mac, M.J., and C.C. Edsall. 1991. Environmental contaminants and the reproductive success of lake trout in the Great Lakes: An epidemiological approach. Journal of Toxicology and Environmental Health 33:375-394.

Mayfield RB, Cech JJ Jr. 2004. Temperature effects on green sturgeon bioenergetics. Trans Am Fish Soc 133:961–970

Morgan, R.P., V.J. Rasin and L.A. Noe. 1973. Effects of Suspended Sediments on the Development of Eggs and Larvae of Striped Bass and White Perch. Natural resources Institute, Chesapeake Biological Laboratory, U of Maryland, Center for Environmental and Estuarine Studies. 20 pp.

Moser, M.L. and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234.

NAST (National Assessment Synthesis Team). 2008. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000
http://www.usgcrp.gov/usgcrp/Library/nationalassessment/1IntroA.pdf

NMFS, 1996. Status Review of shortnose sturgeon in the Androscoggin and Kennebec Rivers. Northeast Regional Office, National Marine Fisheries Service, unpublished report. 26 pp.

NMFS. 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.

NOAA. 1979. Testimony of Dr. Dadswell. May 14, 1979. Docket C/II-WP-77-01.

NRC 2010. Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Supplement 38 – Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3. Final Report. NUREG-1437, Supplement 38

NRC 2009. Biological Assessment to NMFS for Indian Point relicensing. Unpublished report transmitted to NMFS.

NRC 2010b. Revised Biological Assessment to NMFS for Indian Point relicensing. December 2010.

NRC 2011. Supplement to Biological Assessment to NMFS for Indian Point relicensing.

NYHS (New York Historical Society as cited by Dovel as Mitchell. S. 1811). 1809. Volume1. Collections of the New-York Historical Society for the year 1809.

NYDEC. 1982. State Pollution Discharge Elimination System Final Permit for Indian Point Nuclear Generating Station.

NYSDEC (New York State Department of Environmental Conservation). 2003. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2 Bowline 1 and 2 and IP2 and IP3 2 and 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties" (Hudson River Power Plants FEIS). June 25, 2003.

NYDEC. 2010. Letter from W. Adriance to D. Grey, Entergy. Denial of 401 WQC. April 2, 2010.

Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (Acipenser oxyrinchus and A. brevirostrum) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.

O'Herron, J.C., K.W. Able, and R.W. Hastings. 1993. Movements of shortnose sturgeon (*Acipenser brevirostrum)* in the Delaware River. Estuaries 16:235-240.

Parker E. 2007. Ontogeny and life history of shortnose sturgeon (*Acipenser brevirostrum* lesueur 1818): effects of latitudinal variation and water temperature. Ph.D. Dissertation. University of Massachusetts, Amherst. 62 pp.

Pekovitch, A.W. 1979. Distribution and some life history aspects of shortnose sturgeon (*Acipenser brevirostrum)* in the upper Hudson River Estuary. Hazleton Environmental Sciences Corporation. 67 pp.

Rogers, S. G., and W. Weber. 1994. Occurrence of shortnose sturgeon (Acipenser brevirostrum) in the Ogeechee-Canoochee river system, Georgia during the summer of 1993. Final Report of the United States Army to the Nature Conservancy of Georgia.

Rogers, S.G., and W. Weber. 1995a. Movements of shortnose sturgeon in the Altamaha River system, Georgia. Contributions Series #57. Coastal Resources Division, Georgia Department of

Natural Resources, Brunswick, Georgia.

Rogers, S.G., and W. Weber. 1995b. Status and restoration of Atlantic and shortnose sturgeons in Georgia. Final Report to the National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.

Ruelle, R., and K.D. Keenlyne. 1993. Contaminants in Missouri River pallid sturgeon. Bull. Environ. Contam. Toxicol. 50: 898-906.

Ruelle, R. and C. Henry. 1994. Life history observations and contaminant evaluation of pallid sturgeon. Final Report U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, South Dakota Field Office, 420 South Garfield Avenue, Suite 400, Pierre, South Dakota 57501-5408.

Sherk, J.A. J.M. O'Connor and D.A. Neumann. 1975. Effects of suspended and deposited sediments on estuarine environments. *In*: Estuarine Research Vol. II. Geology and Engineering. L.E. Cronin (editor). New York: Academic Press, Inc.

Skjeveland, Jorgen E., Stuart A. Welsh, Michael F. Mangold, Sheila M. Eyler, and Seaberry Nachbar. 2000. A Report of Investigations and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake bay (1996-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 44 pp.

Smith, Hugh M. and Barton A. Bean. 1899. List of fishes known to inhabit the waters of the District of Columbia and vicinity. Prepared for the United States Fish Commission. Washington Government Printing Office, Washington, D.C.

Snyder, D.E. 1988. Description and identification of shortnose and Atlantic sturgeon larvae. American Fisheries Society Symposium 5:7-30.

Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. U.S. Fish and Wildlife Service, Charles City, Virginia.

Squiers, T., L. Flagg, and M. Smith. 1982. American shad enhancement and status of sturgeon stocks in selected Maine waters. Completion report, Project AFC-20.

Squiers, T. And M. Robillard. 1997. Preliminary report on the location of overwintering sites for shortnose sturgeon in the estuarial complex of the Kennebec River during the winter of 1996/1997. Unpublished report, submitted to the Maine Department of Transportation.

Swanson, C., D. Crowley, Y. Kim, N. Cohn, and D. Mendelsohn. 2011a. Part 2 of Response to the NYSDEC Staff Review of the 2010 Field Program and Modeling Analyis of the Cooling Water Discharge from the Indian Point Energy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. ML 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Swanson, C., D. Mendelsohn, N. Cohn, D. Crowley, Y. Kim, L Decker, and L Miller. 2011 b. Final Report: 2010 Field Program and Modeling Analysis of the Cooling Water Discharge from the Indian Point Entergy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. **ML** 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Taubert, B.D. 1980b. Biology of shortnose sturgeon (Acipenser brevirostrum) in the Holyoke Pool, Connecticut River, Massachusetts. Ph.D. Thesis, University of Massachusetts, Amherst, 136 p.

Taubert, B.D., and M.J. Dadswell. 1980. Description of some larval shortnose sturgeon (Acipenser brevirostrum) from the Holyoke Pool, Connecticut River, Massachusetts, USA, and the Saint John River, New Brunswick, Canada. Canadian Journal of Zoology 58:1125-1128.

Uhler, P.R. and O. Lugger. 1876. List of fishes of Maryland. Rept. Comm. Fish. MD. 1876: 67-176.

USDOI (United States Department of Interior). 1973. Threatened wildlife of the United States. Shortnose sturgeon. Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, Washington, D.C. Resource Publication 114 (Revised Resource Publication 34).

Varanasi, U. 1992. Chemical contaminants and their effects on living marine resources. pp. 59-71. in: R. H. Stroud (ed.) Stemming the Tide of Coastqal Fish Habitat Loss. Proceedings of the Symposium on Conservation of Fish Habitat, Baltimore, Maryland. Marine Recreational Fisheries Number 14. National Coalition for Marine Conservation, Inc., Savannah Georgia.

Vinyard, L. and W.J. O'Brien. 1976. Effects of light and turbidity on the reactive distance of bluegill (*Lepomis macrochirus*) J. Fish. Res. Board Can. 33: 2845-2849.

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidea. Pages 24-60 in Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(Part III). xxi + 630 pp.

Von Westernhagen, H., H. Rosenthal, V. Dethlefsen, W. Ernst, U. Harms, and P.D. Hansen. 1981. Bioaccumulating substances and reproductive success in Baltic flounder Platichthys flesus. Aquatic Toxicology 1:85-99.

Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L. and J. Waldman. 2005. Range-wide population structure of shortnose sturgeon Acipenser brevirostrum based on sequence analysis of mitochondrial DNA control region. Estuaries 28:406-21.

Waldman JR, Grunwald C, Stabile J, Wirgin I. 2002. Impacts of life history and biogeography on genetic stock structure in Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, Gulf sturgeon *A. oxyrinchus desotoi*, and shortnose sturgeon, *A.brevirostrum.* J Appl Ichthyol 18:509-518

Walsh, M.G., M.B. Bain, T. Squires, J.R. Walman, and Isaac Wirgin. 2001. Morphological and genetic variation among shortnose sturgeon Acipenser brevirostrum from adjacent and distant rivers. Estuaries Vol. 24, No. 1, p. 41-48. February 2001.

Waters, Thomas F. 1995. Sediment in Streams. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, MD. Pages 95-96.

Weber, W. 1996. Population size and habitat use of shortnose sturgeon, Acipenser brevirostrum, in the Ogeechee River sytem, Georgia. Masters Thesis, University of Georgia, Athens, Georgia.

Welsh, Stuart A., Michael F. Mangold, Jorgen E. Skjeveland, and Albert J. Spells. 2002. Distribution and Movement of Shortnose Sturgeon (*Acipenser brevirostrum*) in the Chesapeake Bay. Estuaries Vol. 25 No. 1: 101-104.

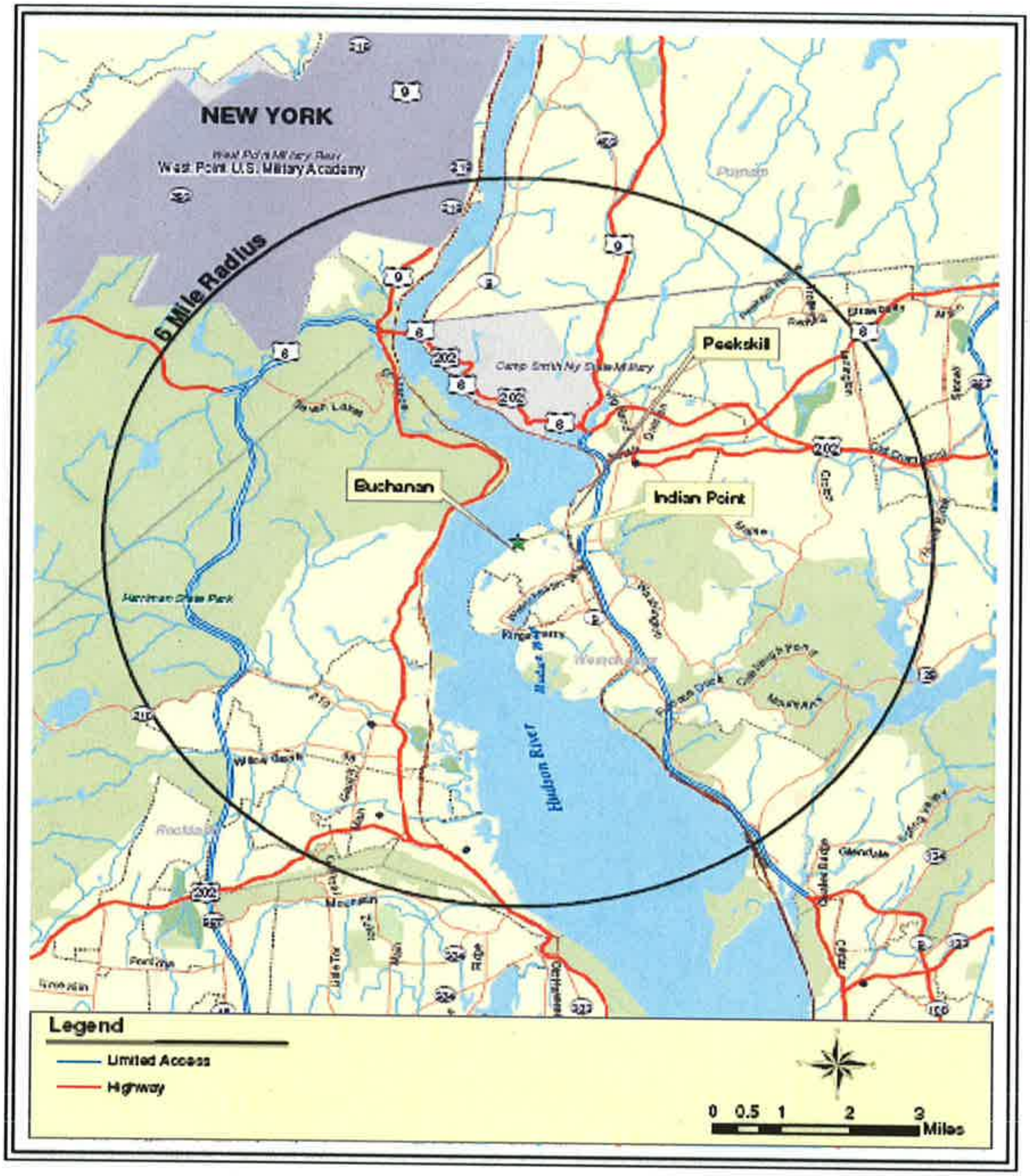
Wilber, Dara H. and Douglas C. Clarke. 2001. Biological Effects of Suspended Sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Woodland, R. J. 2005. Age, growth, and recruitment of Hudson River shortnose sturgeon (Acipenser brevirostrum). Master's thesis. University of Maryland, College Park.

Woodland, R.J. and D. H. Secor. 2007. Year-class strength and recovery of endangered shortnose sturgeon in the Hudson River, New York. Transaction of the American Fisheries Society 136:72-81.

Ziegeweid, J.R., C.A. Jennings, and D.L. Peterson. 2008a. Thermal maxima for juvenile shortnose sturgeon acclimated to different temperatures. Environmental Biology of Fish 3: 299-307.

Ziegeweid, J.R., C.A. Jennings, D.L. Peterson and M.C. Black. 2008b. Effects of salinity, temperature, and weight on the survival of young-of-year shortnose sturgeon. Transactions of the American Fisheries Society 137:1490-1499.

Figure 1

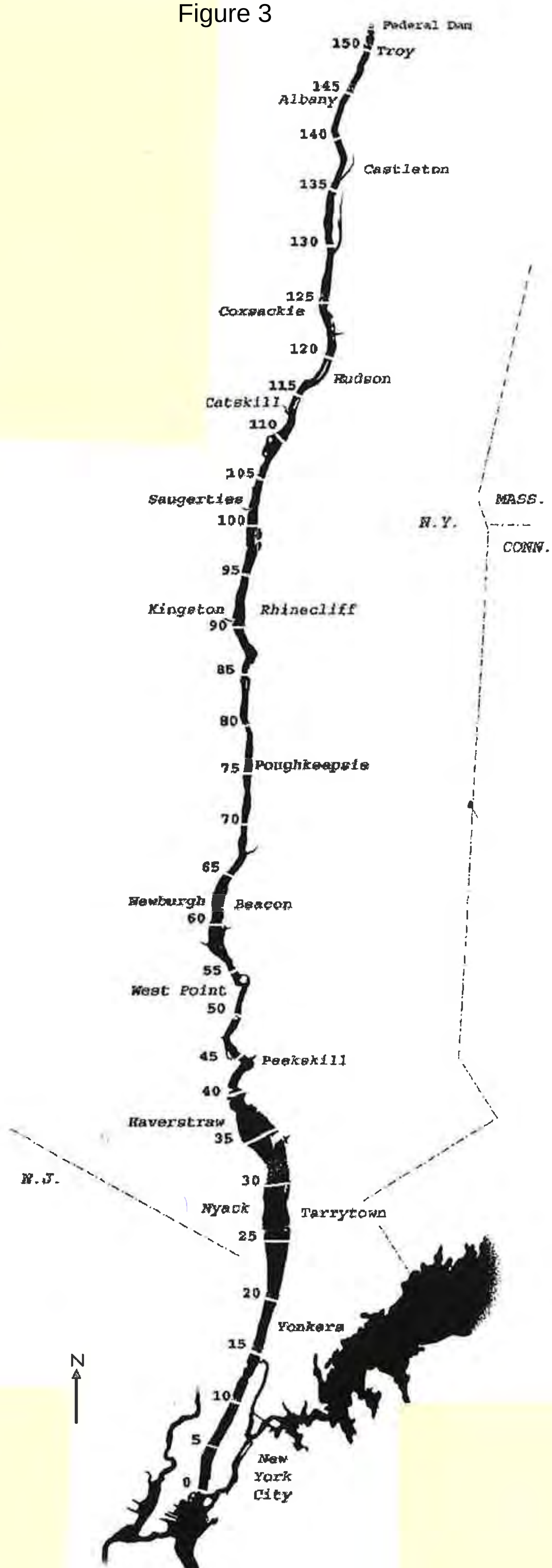


Location of Indian Point, View 1

Figure 2

Location of Indian Point, View 2

Figure 3



Hudson River Miles
p. 80

Appendix I
Incident Report Shortnose Sturgeon Take – Indian Point

Photographs should be taken and the following information should be collected from all sturgeon (alive and dead) found in association with the Indian Point intakes. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name:____
Reporter's full name:____

Species Identification (Key attached):____

Site of Impingement (Unit 2 or 3, CWS or DWS, Bay #, etc.):________________________________

Date animal observed:________________ Time animal observed: ________________________
Date animal collected:________________ Time animal collected:_________________________

Environmental conditions at time of observation (i.e., tidal stage, weather):
____
____

Date and time of last inspection of intakes:____________________________________
Water temperature (°C) at site and time of observation:_________________________
Number of pumps operating at time of observation:_____________________________________
Average percent of power generating capacity achieved per unit at time of observation:________
Average percent of power generating capacity achieved per unit over the 48 hours previous to observation:____

Sturgeon Information:
Species ___________________________________

Fork length (or total length) ______________________ Weight _______________________

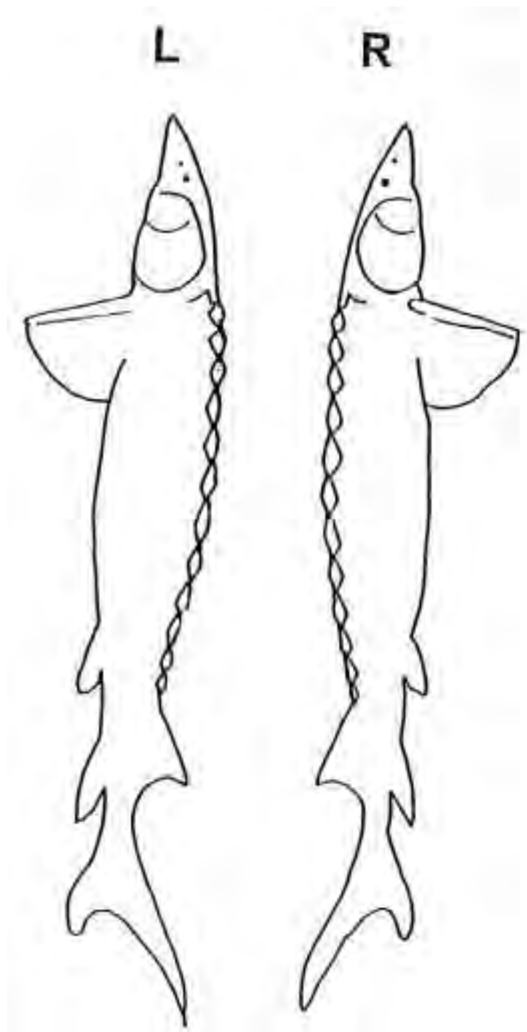
Condition of specimen/description of animal
____
____
____
____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish tagged: YES / NO *Please record all tag numbers.* Tag # ________________

Photograph attached: YES / NO
(please label *species, date, geographic site* and *vessel name* on back of photograph)

Appendix I, continued

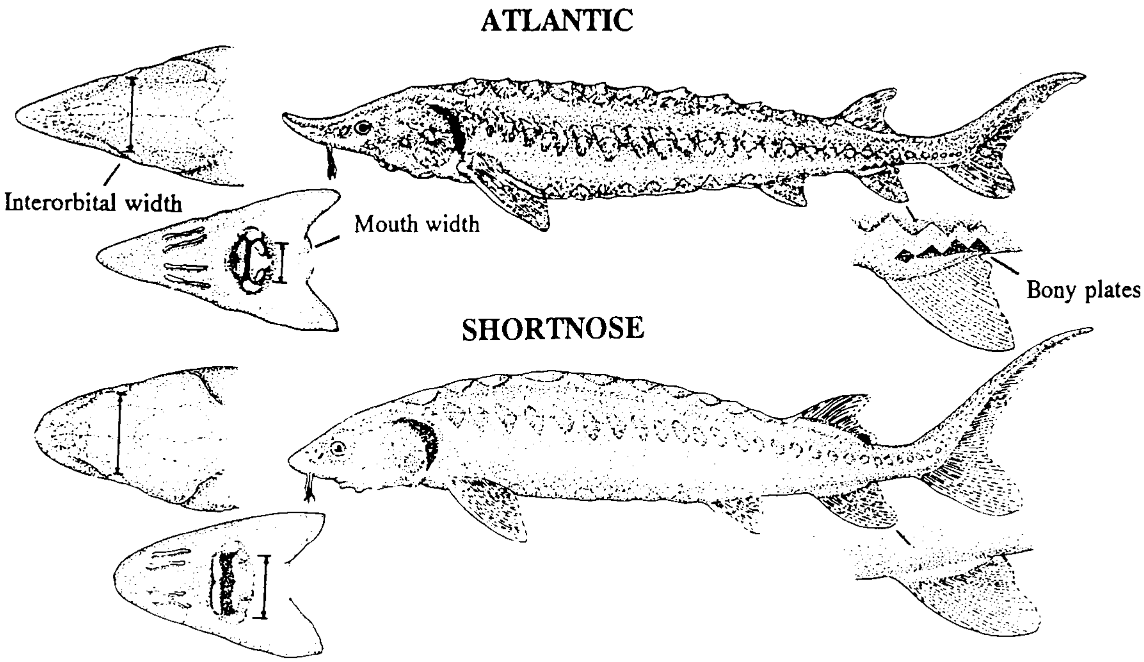
Draw wounds, abnormalities, tag locations on diagram and briefly describe below



Description of fish condition:

Appendix II

Identification Key for Sturgeon Found in Northeast U.S. Waters



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

Characteristic	**Atlantic Sturgeon, *Acipenser oxyrinchus***	**Shortnose Sturgeon, *Acipenser brevirostrum***
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004

APPENDIX III

Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

1. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

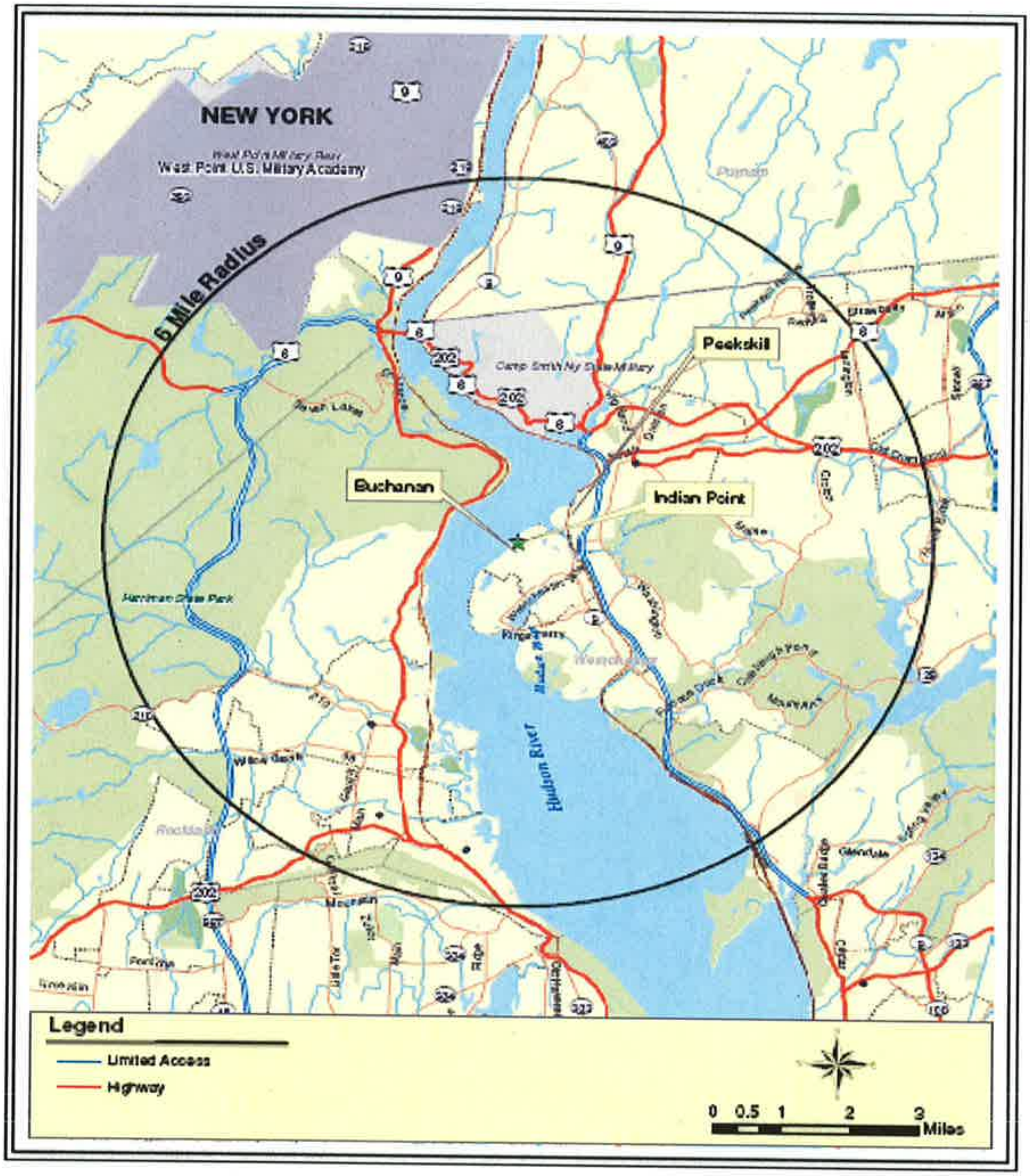
Sending of Sample

1. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547

   a. Prior to sending the sample, contact Russ Bohl at NMFS Northeast Regional Office (978-282-8493) to report that a sample is being sent and to discuss proper shipping procedures.

Figure 1

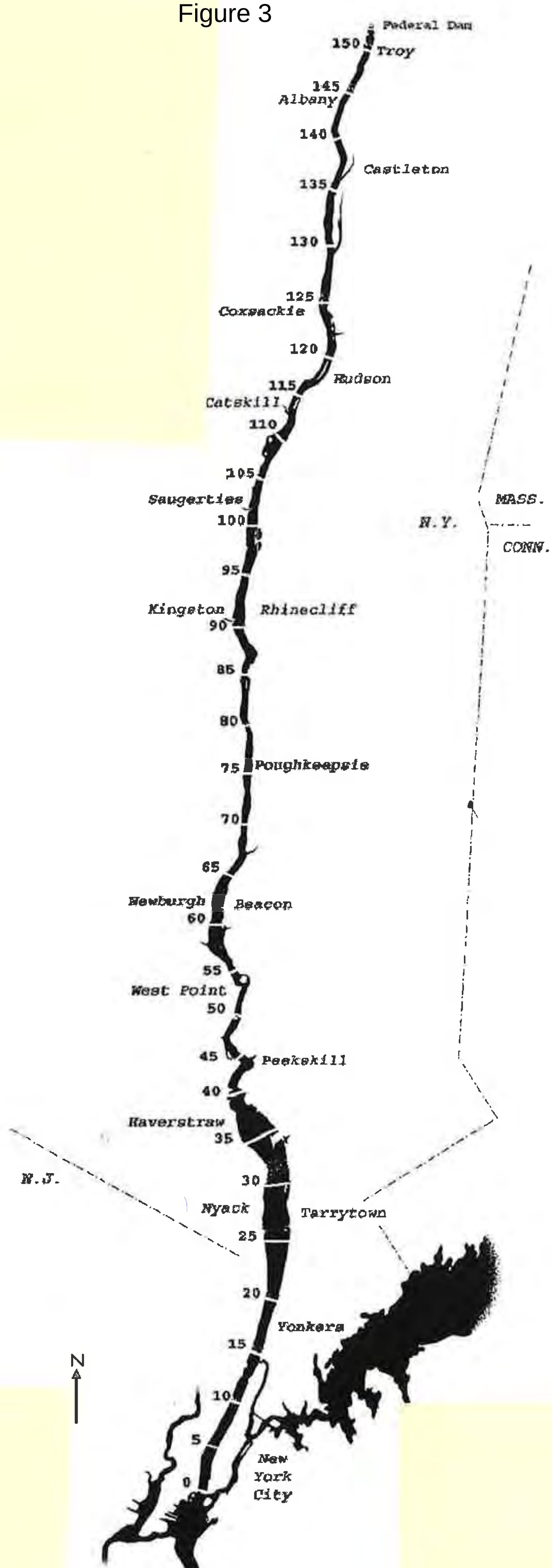


Location of Indian Point, View 1
p. 78

Figure 2

Location of Indian Point, View 2

Figure 3



Hudson River Miles
p. 80

Riverkeeper Amended Contention RK-EC-8A:
Attachment 4

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
DRAFT
BIOLOGICAL OPINION

Agency: Nuclear Regulatory Commission

Activity: **Continued Operations of the Indian Point Nuclear Generating Station F/NER/2012/02252**

Conducted by: NOAA's National Marine Fisheries Service
Northeast Regional Office

Date Issued: ________DRAFT____________________

Approved by: _________DRAFT_________________

Table of Contents

1.0 INTRODUCTION

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) issued in accordance with section 7 of the Endangered Species Act of 1973, as amended, on the effects of the continued operation of the Indian Point Nuclear Generating Station (Indian Point) pursuant to an existing operating license issued by the Nuclear Regulatory Commission (NRC) in accordance with the Atomic Energy Act of 1954 as amended (68 Stat. 919) and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242) as well as proposed extended operating licenses.

This Opinion is based on information provided in a Biological Assessment (BA) dated December 2010, the *Final Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38 Regarding Indian Point Nuclear Generating Unit 2 and 3* dated December 2010, a draft Supplement to that EIS dated June 2012, information submitted to us by the NRC via letter dated May 16, 2012, permits issued by the State of New York, information submitted to NMFS by Entergy and other sources of information. We will keep a complete administrative record of this consultation at the NMFS Northeast Regional Office, Gloucester, Massachusetts.

2.0 BACKGROUND AND CONSULTATION HISTORY

Indian Point Nuclear Generating Units 2 and 3 (IP2 and IP3) are located on approximately 239 acres (97 hectares (ha)) of land in the Village of Buchanan in upper Westchester County, New York (project location is illustrated in Appendix I, Figures 1 and 2). The facility is on the eastern bank of the Hudson River at river mile (RM) 43 (river kilometer (RKM) 69) about 2.5 miles (mi) (4.0 kilometers (km)) southwest of Peekskill, the closest city, and about 43 mi (69 km) north of the southern tip of Manhattan. Both IP2 and IP3 use Westinghouse pressurized-water reactors and nuclear steam supply systems (NSSSs). Primary and secondary plant cooling is provided by a once-through cooling water intake system that supplies cooling water from the Hudson River. Indian Point Nuclear Generating Station Unit 1 (IP1, now permanently shut down[1]) shares the site with IP2 and IP3. IP1 is located between IP2 and IP3. In 1963, IP1 began operations. IP1 was shut down on October 31, 1974, and is in a safe storage condition (SAFSTOR) awaiting final decommissioning. Construction began on IP2 in 1966 and on IP3 in 1969.

The Atomic Energy Commission (AEC), the predecessor to the NRC, initially licensed IP2 on September 28, 1973. The AEC issued a 40-year license for IP2 that will expire on September 29, 2013. IP2 was originally licensed to the Consolidated Edison Company, which sold that facility to Entergy in September 2001. IP3 was initially licensed on December 12, 1975, for a 40-year period that will expire in December 2015. While the Consolidated Edison Company of New York originally owned and operated IP3, it was later conveyed to the Power Authority of the State of New York (PASNY – the predecessor to the New York Power Authority [NYPA]). PASNY/NYPA operated IP3 until November 2000 when it was sold to Entergy.

[1] The intake for IP1 is used for service water for IP2; however, IP1 no longer is used for generating electricity and no cooling water is withdrawn from the IP1 intake. This use is discussed fully below.

2.1 Endangered Species Act Consultation

The Endangered Species Act was enacted in 1973. However, there was no requirement in the 1973 Act for the Secretary to produce a written statement setting forth his biological opinion on the effects of the action and whether the action will jeopardize the continued existence of listed species and/or destroy or adversely modify critical habitat. It was not until Congress amended the Act in 1978 that the Secretary was required to produce a Biological Opinion. The 1973 Act, including as amended in 1978, prohibited the "take" of endangered species. NMFS could issue a Section 10 incidental take permit to those who applied for incidental take authorization. In 1982, Congress amended the Act to provide for an "Incidental Take Statement" (ITS) in a Biological Opinion that specifies the level of incidental "take," identifies measures to minimize the level of incidental "take," and exempts any incidental "take" that occurs in compliance with those measures. Until we issued a Biological Opinion with ITS for shortnose sturgeon in 2011, we had not exempted any incidental take at IP1, IP2 and IP3 from the Section 9 prohibitions against take, either through a Section 10 permit or an ITS. The ITS issued with the 2011 Opinion was only prospective, that is, it covered the period from September 28, 2013-September 28, 2033 (IP1 & 2) and December 12, 2015-December 12, 2035 (IP3)..

As explained below, beginning in 1977, EPA held a series of hearings (Adjudicatory Hearing Docket No. C/II-WP-77-01) regarding the once through cooling systems at Indian Point, Roseton, Danskammer and Bowline Point, all of which are power facilities located along the Hudson River. During the course of these hearings, Dr. Mike Dadswell testified on the effects of the Indian Point facility on shortnose sturgeon. In a filing dated May 14, 1979, NOAA submitted this testimony to the U.S. EPA as constituting NMFS "Biological Opinion on the impacts of the utilities' once through cooling system on the shortnose sturgeon." The filing notes that this opinion is required by section 7 of the ESA of 1973, as amended.

In this testimony, Dr. Dadswell provides information on the life history of shortnose sturgeon and summarizes what was known at the time about the population in the Hudson River. Dr. Dadswell indicates that at the time it was estimated that there were approximately 6,000 adult and sub-adult shortnose sturgeon in the Hudson River population (Dadswell 1979) and that the population had been stable at this number between the 1930s and 1970s. Dr. Dadswell determined that there is no known entrainment of shortnose sturgeon at these facilities and little, if any, could be anticipated. Based on available information regarding impingement at IP2 and IP3, Dadswell estimated a worst case scenario of 35 shortnose sturgeon impingements per year, including 21 mortalities (assuming 60% impingement mortality). Dadswell estimated that this resulted in a loss of 0.3-0.4% of the shortnose sturgeon population in the Hudson each year and that this additional source of mortality will not "appreciably reduce the likelihood of the survival and recovery of the shortnose sturgeon." In conclusion Dadswell stated that the once through cooling systems being considered in the case were "not likely to jeopardize the continued existence of the shortnose sturgeon because, even assuming 100% mortality of impinged fish, its contribution to the natural annual mortality is negligible." Dr. Dadswell did note that as there is no positive benefit to impingement, any reductions in the level of impingement would aid in the conservation of the species. Incidental take of shortnose sturgeon at IP2 and IP3 was not exempted from the prohibitions on take by this testimony or "biological opinion." No additional ESA consultation occurred between NRC and NMFS on the operation of IP2 and IP3 until consultation was initiated in 2010 on the effects to shortnose sturgeon of operations during the proposed extended operating period.

In advance of relicensing proceedings, NRC began coordination with us in 2007. In a letter dated August 16, 2007, NRC requested information from us on federally listed endangered or threatened species, as well as on proposed or candidate species, and on any designated critical habitats that may occur in the vicinity of IP2 and IP3. In our response, dated October 4, 2007, we expressed concern that the continued operation of IP2 and IP3 could have an impact on the shortnose sturgeon *(Acipenser brevirostrum*). In a letter dated December 22, 2008, NRC requested formal consultation with us to consider effects of the proposed relicensing on shortnose sturgeon. With this letter, NRC transmitted a BA. In a letter dated February 24, 2009, we requested additional information on effects of the proposed relicensing on shortnose sturgeon. In a letter dated December 10, 2010, NRC provided the information that was available and transmitted a revised BA. In the original BA, NRC staff relied on data originally supplied by the applicant, Entergy Nuclear Operations, Inc. (Entergy). NRC sought and Entergy later submitted revised impingement data, which was incorporated into the final BA. Mathematical errors in the original data submitted to the NRC resulted in overestimates of the impingement of shortnose sturgeon that the NRC staff presented in the 2008 BA. Consultation on the effects of the proposed relicensing on shortnose sturgeon was initiated on December 10, 2010.

On June 16, 2011, we received information regarding Entergy's triaxial thermal plume study and NMFS staff obtained a copy of the study and supporting documentation from NYDEC's webpage on that date. Additional information regarding the intakes was provided by Entergy via conference call on June 20, June 22, and June 29, 2011. Supplemental information responding to specific questions raised by us regarding the thermal plume was submitted by Entergy via e-mail on July 8, July 25, and August 5, 2011. NRC provided us with a supplement to the December 2010 BA considering the new thermal plume information, on July 27, 2011. We transmitted a draft Opinion to NRC on August 26, 2011. The draft Opinion was subsequently transmitted by NRC to Entergy. Comments on the draft Opinion were received by us from NRC on September 6, 2011 and September 20, 2011. Comments were received by us from Entergy on September 6, 2011. Additionally, we received letters regarding the draft Opinion from New York State (dated September 6, 2011) and Hudson Riverkeeper (dated September 15, 2011). Additional clarifying information on the proposed action was received from NRC and Entergy throughout September 2011. We issued a Biological Opinion on October 14, 2011. In this Opinion we concluded that operation of IP2 and IP3 during the extended operating period was likely to adversely affect but not likely to jeopardize the continued existence of shortnose sturgeon.

As explained in the "Effects of the Action" section of the 2011 Opinion, we determined an average of 5 shortnose sturgeon per year are likely to be impinged at Unit 2 during the extended operating period, with a total of no more than 104 shortnose sturgeon over the 20 year period (dead or alive). Additionally, over the 20 year operating period, we estimated that an additional 6 shortnose sturgeon (dead or alive) were likely to be impinged at the Unit 1 intakes which will provide service water for the operation of Unit 2. We estimated that at Unit 3, an average of 3 shortnose sturgeon are likely to be impinged per year during the extended operating period, with a total of no more than 58 shortnose sturgeon (dead or alive) taken as a result of the operation of Unit 3 over the 20 year period. This level of take was exempted through an Incidental Take Statement that applies only to the period when the facility operates under a new operating license

(September 28, 2013 through September 28, 2033 for Units 1 and 2; December 12, 2015 through December 12, 2035 for Unit 3). The 2011 Opinion was to become effective once new operating licenses were issued by NRC. The Nuclear Regulatory Commission (NRC) has not yet made a decision on whether to issue the extended operating licenses.

As described in 50 CFR§ 402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) the amount or extent of taking specified in the ITS is exceeded; (b) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) any of the identified actions are subsequently modified in a manner that causes an effect to the listed species that was not considered in the Opinion; or (d) a new species is listed or critical habitat designated that may be affected by the identified actions. Based on prior communications with NRC, it is our understanding that for Indian Point facilities, NRC retains discretionary involvement or control to benefit listed species, or such involvement or control is authorized by law, and that NRC will reinitiate consultation if any of the criteria above are satisfied.
On February 6, 2012, we listed five distinct population segments (DPS) of Atlantic sturgeon as threatened (Gulf of Maine DPS) or endangered (New York Bight, Chesapeake Bay, Carolina and South Atlantic DPSs) (see 77 FR 5880 and 77 FR 5914). Atlantic sturgeon occur in the Hudson River and are known to be affected by operations of IP2 and IP3.

In a letter dated May 17, 2012, NRC requested reinitiation of the 2011 consultation to consider effects of operations of IP2 and IP3 during the extended operating period on Atlantic sturgeon. As described by NRC staff in a telephone call on July 3, 2012, NRC also requests that the consultation consider effects to shortnose sturgeon and five DPSs of Atlantic sturgeon of operations of IP2 and IP3 pursuant to the existing operating licenses up until such time as extended operating licenses are issued or operations cease. Therefore, the federal actions under consideration are authorization of operations of IP2 and IP3 by the NRC pursuant to licenses issued in 1973 and 1975, respectively, and operations pursuant to proposed new licenses, which NRC may issue at any time and would extend operations for 20 years beyond the expiration of the original licenses. Consultation was initiated on May 17, 2012. On July 23, 2012, Entergy submitted additional information to us and NRC regarding impingement of shortnose and Atlantic sturgeon (Entergy 2012). Subsequently, by mutual agreement of NRC and NMFS, we extended the consultation period by 60 days to allow time for review and incorporation of this new information, as appropriate. By issuing this Opinion, we withdraw the Opinion issued by us on October 14, 2011.

3.0 DESCRIPTION OF THE PROPOSED ACTION

As noted above, the proposed Federal action is the continued operation of Indian Point Units 2 and 3 pursuant to licenses issued by NRC in 1973 and 1975, respectively, as well as continued operation of IP2 and IP3 pursuant to NRC's proposed renewed operating licenses. The current 40-year licenses expire in 2013 (IP2) and 2015 (IP3). According to NRC, NRC's "timely renewal" provision (in 10 CFR 2.109(b)) provides that if a license renewal application is timely filed, which NRC asserts the Entergy application was, the current license is not deemed to have expired until the application has been finally determined (i.e., until a licensing decision is made). Thus, pursuant to this provision, the current operating licenses will not expire until the license renewal proceeding has concluded. NRC's proposed relicensing would authorize the extended operation of IP2 and IP3 for an additional 20 years (i.e., through September 28, 2033 and December 12, 2035, respectively). In this Opinion, we consider the potential impacts of the continued operation of the facility from now through the proposed extended operation period on shortnose and Atlantic sturgeon.

Details on the operation of the facilities under the terms of the existing license and over the extended operating period, as proposed by Entergy in the license application and as described by NRC in the FEIS, DSEIS and BA, and are summarized below. Both units withdraw water from and discharge water to, the Hudson River. As described by NRC in the Final SEIS (NRC 2010), in 1972, Congress assigned authority to administer the Clean Water Act (CWA) to the US Environmental Protection Agency (EPA). The CWA further allowed EPA to delegate portions of its CWA authority to states. On October 28, 1975, EPA authorized the State of New York to issue National Pollutant Discharge Elimination System (NPDES) permits. New York's NPDES, or State Pollutant Discharge Elimination System (SPDES), program is administered by the NY Department of Environmental Conservation (NYDEC). NYDEC issues and enforces SPDES permits for IP2 and IP3.

Section 316(b) of the Clean Water Act of 1977 requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). EPA regulates impingement and entrainment under Section 316(b) of the CWA through the NPDES permit process. Administration of Section 316(b) has also been delegated to NYDEC, and that provision is implemented through the SPDES program.

Neither IP2 or IP3 can operate without cooling water, and NRC is responsible for authorizing the operation of nuclear facilities, as well as approving any extension of an initial operating license through the license renewal process. Intake and discharge of water through the cooling water system would not occur but for the operation of the facility pursuant to a renewed license; therefore, the effects of the cooling water system on shortnose sturgeon are a direct effect of the proposed action. NRC staff state that the authority to regulate cooling water intakes and discharges under the CWA lies with EPA, or in this case, NYDEC, as the state has been delegated NPDES authority by EPA. Pursuant to NRC's regulations, operating licenses are conditioned upon compliance with all applicable law, including but not limited to CWA Section 401 Certifications and NPDES/SPDES permits. Therefore, the effects of the proposed Federal action-- the continued operation of IP2 and IP3 as proposed to be approved by NRC, which necessarily involves the removal and discharge of water from the Hudson River-- are shaped not only by the terms of the renewed operating license but also by the NYDEC 401 Water Quality Certification and any conditions it may contain that would be incorporated into its SPDES permits. This Opinion will consider the effects of the operation of IP2 and IP3 pursuant to the extended Operating License to be issued by the NRC and the SPDES permits issued by NYDEC that are already in effect. NRC requested consultation on the operation of the facilities under the existing NRC license terms and the existing SPDES permits, even though a new SPDES permit might be issued in the future. A complete history of NYDEC permits is included in NRC's FSEIS at Section 2.2.5.3 (Regulatory Framework and Monitoring Programs) and is summarized below.

3.1 NPDES/SPDES Permits

Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). In July 2004, the EPA published the Phase II Rule implementing Section 316(b) of the CWA for Existing Facilities (69 FR 41576), which applied to large power producers that withdraw large amounts of surface water for cooling (50 MGD or more) (189,000 m3/day or more). The rule became effective on September 7, 2004 and included numeric performance standards for reductions in impingement mortality and entrainment that would demonstrate that the cooling water intake system constitutes BTA for minimizing impingement and entrainment impacts. Existing facilities subject to the rule were required to demonstrate compliance with the rule's performance standards during the renewal process for their NPDES permit through development of a Comprehensive Demonstration Study (CDS). As a result of a Federal court decision, EPA officially suspended the Phase II rule on July 9, 2007 (72 FR 37107) pending further rulemaking. EPA instructed permitting authorities to utilize best professional judgment in establishing permit requirements on a case by-case basis for cooling water intake structures at Phase II facilities until it has resolved the issues raised by the court's ruling.

The licenses issued by the AEC for IP2 and IP3 initially allowed for the operation of those facilities with once-through cooling systems. However, the licenses required the future installation of closed-cycle cooling systems at both facilities, by certain dates, because of the potential for long term environmental impact from the once-through cooling systems on aquatic life in the Hudson River, particularly striped bass. A closed cycle cooling system is expected to withdraw approximately 90-95% less water than a once through cooling system. The license for IP2 was amended by the NRC in 1975, and the license for IP3 was amended by the NRC in 1976, to include requirements for the installation and operation of wet closed-cycle cooling systems at the facilities.

NRC eventually concluded that the operating licenses for the facilities should be amended to authorize construction of natural draft cooling towers at each Unit. Prior to the respective deadlines for installation of closed-cycle cooling at the Indian Point facilities, however, the NRC's authority to require the retrofit due to water quality impacts under federal nuclear licenses was superseded by comprehensive amendments to the federal Water Pollution Prevention and Control Act (the CWA) and creation of the NPDES program.

In 1975, the EPA issued separate NPDES permits for Units 2 and 3, pursuant to provisions of the CWA, chiefly § 316 (33 U.S.C. § 1326), that required both facilities to discontinue discharging heated effluent from the main condensers. The NPDES permits provided that "heat may be discharged in blowdown from a re-circulated cooling water system." The intent of these conditions was to require the facilities to install closed-cycle cooling systems in order to reduce the thermal and other adverse environmental impacts from the operation of Indian Point's CWISs upon aquatic organisms in the Hudson River. In 1977, the facilities' owners, Consolidated Edison Company of New York and PASNY/NYPA, requested administrative hearings with the EPA to overturn these conditions.

In October 1975, NYDEC received approval from the EPA to administer and conduct a State permit program pursuant to the provisions of the federal NPDES program under CWA § 402. Since then, NYDEC has administered that program under the SPDES permit program. As a result, NYDEC has the authority, under the CWA and state law, to issue SPDES permits for the withdrawal of cooling water for operations at the Indian Point facilities and for the resulting discharge of waste heat and other pollutants into the Hudson River. Compliance with the SPDES permit would be required under the Federal action given that the operating license shall be subject to the conditions imposed under the CWA.

As previously noted, in 1977 the then-owners of the Indian Point nuclear facilities sought an adjudicatory proceeding to overturn the EPA-issued NPDES permit determinations that limited the scope of the facilities' cooling water intake operations. The EPA's adjudicatory process lasted for several years before culminating in a multi-party settlement known as the Hudson River Settlement Agreement[2] (HRSA). The HRSA was initially a ten-year agreement whereby the owners of certain once-through cooled electric generating plants on the Hudson River, including IP2 and IP3, would collect biological data and complete analytical assessments to determine the scope of adverse environmental impact caused by those facilities. According to the NYDEC, the intent of the HRSA was that, based upon the data and analyses provided by the facilities, the Department could determine, and parties could agree upon, the best technology available to minimize adverse environmental impact on aquatic organisms in the Hudson River from these facilities in accordance with 6 NYCRR § 704.5. The Settlement obligated the utilities to undertake a series of operational steps to reduce fish kills, including partial outages during the key spawning months. In addition, the utilities agreed to fund and operate a striped bass hatchery, conduct biological monitoring, and set up a $12 million endowment for a new foundation for independent research on mitigating fish impacts by power plants. The agreement became effective upon Public Service Commission approval on May 8, 1981. The terms of the 1980 HRSA were extended through a series of four separate stipulations of settlement and judicial consent orders that were entered in Albany County Supreme Court [Index No. 0191-ST3251]. The last of these stipulations of settlement and judicial consent orders, executed by the parties in 1997, expired on February 1, 1998.

In 1982, NYDEC issued a SPDES permit for IP2 and IP3, and other Hudson River electric generating facilities, as well as a CWA § 401 WQC for the facilities. The 1982 SPDES permit for IP2 and IP3 contained special conditions for reducing some of the environmental impact from the facilities' cooling water intakes but, based upon provisions of the HRSA, the permit did not require the installation of any technology for minimizing the number of organisms entrained by the facilities each year. Similarly, based upon provisions of the HRSA, the 1982 § 401 WQC did not make an independent determination that the facilities complied with certain applicable State water quality standards at that time, including 6 NYCRR Part 704 – Criteria Governing Thermal Discharges.

[2] The signatory parties to the HRSA were USEPA, the Department, the New York State Attorney General, the Hudson River Fishermen's Association, Scenic Hudson, the Natural Resources Defense Council, Central Hudson Gas & Electric Co., Consolidated Edison Co., Orange & Rockland Utilities, Niagara Mohawk Power Corp., and PASNY. Entergy was not a party to the HRSA because it did not own the Indian Point facilities at any time during the period covered by the HRSA. NOAA was not a party to the HRSA.

In accordance with the provisions of the HRSA, NYDEC renewed the SPDES permit for IP2 and IP3 in 1987 for another 5-year period. As with the 1982 SPDES permit, the 1987 SPDES permit for IP2 and IP3 contained certain measures from the HRSA that were intended to mitigate, but not minimize, the adverse environmental impact caused by the operation of the facilities' cooling water intakes. The 1987 SPDES permit expired on October 1, 1992. Prior to the expiration date, however, the owners of the facilities at that time, Consolidated Edison and NYPA, both submitted timely SPDES permit renewal applications to the Department and, by operation of the State Administrative Procedure Act (SAPA), the 1987 SPDES permit for Units 2 and 3 is still in effect today. Entergy purchased Units 2 and 3 in 2001 and 2000, respectively, and the 1987 SAPA-extended SPDES permit for the facilities was subsequently transferred to Entergy.

In November 2003, NYDEC issued a draft SPDES permit for IP2 and IP3 that required Entergy, among other things, to retrofit the Indian Point facilities with closed-cycle cooling or an equivalent technology in order to minimize the adverse environmental impact caused by the CWISs in accordance with 6 NYCRR § 704.5 and CWA § 316(b). The draft permit contains conditions which address three aspects of operations at Indian Point: conventional industrial-wastewater pollutant discharges, thermal discharge, and cooling water intake. Limits on the conventional industrial discharges are not proposed to be changed significantly from the previous permit. The draft permit does, however, contain new conditions addressing the thermal discharge and additional new conditions to implement the measures NYDEC has determined to be the best technology available for minimizing impacts to aquatic resources from the cooling water intake, including the installation of a closed cycle cooling system at IP2 and IP3. With respect to thermal discharges, the draft SPDES permit would require Entergy to conduct a tri-axial (three-dimensional) thermal study to document whether the thermal discharges from IP2 and IP3 comply with state water quality criteria. The draft permit states that if IP2 and IP3 do not meet state standards, Entergy may apply for a modification of those criteria in an effort to demonstrate to NYDEC that such criteria are unnecessarily restrictive and that the requested modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish and wildlife in the Hudson River, which is an applicable CWA water quality-related standard. The draft permit also states that Entergy may propose, within a year of the permit's becoming effective, an alternative technology or technologies that can minimize adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3. In order to implement closed-cycle cooling, the draft permit would require Entergy to submit a pre-design engineering report within one year of the permit's effective date. Within one year after the submission of the report, Entergy must submit complete design plans that address all construction issues for conversion to closed-cycle cooling. In addition, the draft permit requires Entergy to obtain approvals for the system's construction from other government agencies, including modification of the operating licenses for IP2 and IP3 from the NRC. While steps are being taken to implement BTA, Entergy would be required to schedule and take annual generation outages of no fewer than 42 unit-days during the peak entrainment season among other measures. In 2004, Entergy requested an adjudicatory hearing with NYDEC on the draft SPDES permit. That SPDES permit adjudicatory process is presently ongoing, and its outcome is uncertain at this time.

There is significant uncertainty associated with the conditions of any new SPDES permit. In the 2003 draft, NYDEC determined that cooling towers were the BTA to minimize adverse environmental effects. In a 2010 filing with NYDEC, Entergy proposed to use a system of cylindrical wedgewire screens, which Entergy states would reduce impingement and entrainment mortality to an extent comparable to the reductions in impingement and entrainment loss expected to result from operation with cooling towers. As no determination has been made regarding a revised draft SPDES permit or a final permit, it is unknown what new technology, if any, will be required to modify the operation of the facility's cooling water intakes. The 1987 SPDES permit is still in effect and will remain in effect until a new permit is issued and becomes effective. No schedule is available for the issuance of a revised draft or new final SPDES permit and the content of any SPDES permit will be decided as a result of the adjudication process. Therefore, in this consultation, we have considered effects of the continued operation of the Indian Point facility through the end of extended operating period with the 1987 SPDES permit in effect. This scenario is the one defined by NRC as its proposed action in the BA provided to NMFS in which NRC considered effects of the operation of the facility during the extended operating period on shortnose and Atlantic sturgeon. Therefore, it is the subject of this consultation. However, if a new SPDES permit is issued, NRC and NMFS would have to determine if reinitiation of this consultation is necessary to consider any effects of the operation of the facility on sturgeon that were not considered in this Opinion, including operation of the facility with cylindrical wedge wire screens. It is possible the effects of the construction, layout, and use of an intake system using cylindrical wedge wire screens will affect shortnose and/or Atlantic sturgeon in a manner and to a degree that is very different from the effects considered in this Opinion, and as a result, necessitate reinitiation of this consultation.

3.2 401 Water Quality Certificate

On December 7, 1970, NYSDEC issued a certification for IP1 and IP2, pursuant to §21(b) of the Water Quality Improvement Act 1 -the precursor to §401. On April 24, 1973, NYSDEC issued a WQC for the operational testing period for IPI and IP2. On September 24, 1973, NYSDEC issued a WQC for full operation of IP1 and IP2. On May 2, 1975, NYSDEC issued a WQC for operation of Indian Point 3 ("IP3"). On April 24, 1981, NYSDEC issued a subsequent WQC for operation of IP1, IP2 and IP3. IP2 and IP3 currently operate pursuant to the 1981 WQC.

On April 6, 2009, NYDEC received a Joint Application for a federal CWA § 401 WQC on behalf of Entergy Indian Point Unit 2, LLC, Entergy Indian Point Unit 3, LLC, and Entergy Nuclear Northeast (collectively Entergy). The Joint Application for § 401 WQC was submitted to NYDEC as part of Entergy's NRC license renewal. Pursuant to the CWA, a state must issue a certification verifying that an activity which results in a discharge into navigable waters, such as operation of the Indian Point facilities, meets state water quality standards before a federal license or permit for such activity can be issued. Entergy has requested NYDEC to issue a § 401 WQC to run concurrently with any renewed nuclear licenses for the Indian Point facilities.

In a decision dated April 2, 2010, NYDEC determined that the facilities, whether operated as they are currently or operated with the addition of a cylindrical wedge-wire screen system (NYDEC notes that this proposal was made by Entergy in a February 12, 2010, submission), "do not and will not comply with existing New York State water quality standards." Accordingly, pursuant to 6 NYCRR Part 621 (Uniform Procedures), NYDEC denied Entergy's request for a

§401 WQC (NYDEC 2010). The reasons for denial, as stated by NYDEC were related to impingement and entrainment of aquatic organisms, the discharge of heated effluent, and failure to implement what NYDEC had determined to be the Best Technology Available (closed cycle cooling towers), to minimize adverse environmental impacts. Entergy has appealed the denial. The matter is currently under adjudication in the state administrative system, and the results are uncertain. If New York State ultimately issues a WQC, it may contain conditions that alter the operation of the facility and its cooling water system. If this occurs, NMFS and NRC would need to review the modifications to operations to determine if consultation would need to be reinitiated.

3.3 Description of Water Withdrawals

IP2 and IP3 have once-through condenser cooling systems that withdraw water from, and discharge water to, the Hudson River. The maximum design flow rate for each cooling system is approximately 1,870 cubic feet per second (cfs), 840,000 gallons per minute (gpm), or 53.0 cubic meters per second (m^3/s). Two shoreline intake structures, one for each unit, are located along the eastern shore of the Hudson River on the northwestern edge of the site and provide cooling water to IP2 and IP3. Each structure consists of seven bays, six for circulating water and one for service water. IP2 also uses service water withdrawn from the former IP1 intake, located along the shoreline between the IP2 and IP3 intakes. The IP2 intake structure has seven independent bays, while the IP3 intake structure has seven bays that are served by a common plenum. In each structure, six of the seven bays contain cooling water pumps, and the seventh bay contains service/auxiliary water pumps. Before it is pumped to the condensers, river water passes through traveling screens in the intake structure bays to remove debris, fish and other aquatic life.

The six IP2 circulating water intake pumps are dual-speed pumps. When operated at high speed (254 revolutions per minute (rpm)), each pump provides 312 cfs (140,000 gpm; 8.83 m3/s) and a dynamic head of 21 ft (6.4 m). At low speed (187 rpm), each pump provides 38 cfs (84,000 gpm; 5.30 m^3/s) and a dynamic head of 15 ft (4.6 m). The six IP3 circulating water intake pumps are variable-speed pumps. When operated at high speed (360 rpm), each pump provides 312 cfs (140,000 gpm; 8.83 m^3/s); at low speed, it provides a dynamic head of 29 ft (8.8 m) and 143 cfs (64,000 gpm; 4.05 m^3/s).

As described in the FSEIS, Entergy adjusts the speed of the intake pumps to mitigate impacts to the Hudson River. Each coolant pump bay is about 15 ft (4.6 m) wide at the entrance, and the bottom is located 27 ft (8.2 m) below mean sea level. Before entering the intake structure bays, water flows under a floating debris skimmer wall, or ice curtain, into the screen wells. This initial screen keeps floating debris and ice from entering the bay. At the entrance to each bay, water also passes through a subsurface bar screen (consisting of metal bars with 3 inch clear spacing) to prevent additional large debris from becoming entrained in the cooling system. At full speed, the approach velocity in front of the screens is 1 foot per second (fps); at reduced speed, the approach velocity is 0.6 fps (Entergy 2007a). As this area is behind a bulkhead it is outside the influence of river currents. Next, smaller debris and fish that pass through the trash bars are screened out using modified Ristroph traveling screens.

Comment [A1]: Questions to NRC and Entergy – What enforceable instrument, if any, requires such speed adjustments? For example, is this speed adjustment a condition of the NRC license and/or a requirement of the NYPDES permit? What factors determine whether a pump is run at full speed versus reduced speed?

The modified Ristroph traveling screens consist of a series of panels that rotate continuously. The traveling screens employed by IP2 and IP3 are modified vertical Ristroph-type traveling screens installed in 1990 and 1991 at IP3 and IP2, respectively. The screens were designed in concert with the Hudson River Fishermen's Association, with screen basket lip troughs to retain water and minimize vortex stress (CHGEC 1999). As each screen panel rotates out of the intake bay, impinged fish are retained in water-filled baskets at the bottom of each panel and are carried over the headshaft, where they are washed out onto a mesh using low-pressure sprays from the rear side of the machine. The 0.25-by-0.5-inch (in.) (0.635-by-1.27 centimeters (cm)) mesh is smooth to minimize fish abrasion by the mesh. Two high-pressure sprays remove debris from the front side of the machine after fish removal. From the mesh, fish return to the river via a 12-in. (30-cm) diameter pipe. For IP2, the pipe extends 200 ft (61.0 m) into the river north of the IP2 intake structure and discharges at a depth of 35 ft (11 m). The sluice system is a 12-in.-diameter (30.5-cm-diameter) pipe that discharges fish into the river at a depth of 35 ft (10.7 m), 200 ft (61 m) from shore (CHGEC 1999). The IP3 fish return system discharges to the river by the northwest corner of the discharge canal.

Comment [A2]: Question to NRC and/or Entergy – Where does material that is removed by the high pressure spray go? Down the sluice?

Studies indicated that, assuming the screens continued to operate as they had during laboratory and field testing, the screens were "the screening device most likely to impose the least mortalities in the rescue of entrapped fish by mechanical means" (Fletcher 1990). The same study concluded that refinements to the screens would be unlikely to greatly reduce fish kills. No monitoring is currently ongoing at IP2 or IP3 for impingement or entrainment or to ensure that the screens are operating per design standards, and no monitoring took place after the screens were installed. Additionally, there is no monitoring ongoing to quantify any actual incidental take of shortnose sturgeon or their prey. The proposed action under consultation, as currently defined by NRC, does not provide for any monitoring of direct or indirect effects to shortnose sturgeon.

After moving through the condensers, cooling water is discharged to the discharge canal via a total of six 96-in. (240-cm) diameter pipes. The cooling water enters below the surface of the 40-ft (12-m) wide canal. The canal discharges to the Hudson River through an outfall structure located south of IP3 at about 4.5 feet per second (fps) (1.4 meters per second (mps)) at full flow. As the discharged water enters the river, it passes through 12 discharge ports (4-ft by 12-ft each (1-m by 3.7-m)) across a length of 252 ft (76.8 m) about 12 ft (3.7 m) below the surface of the river. The increased discharge velocity, about 10 fps (3.0 mps), is designed to enhance mixing to minimize thermal impact.

The discharged cooling water is at an elevated temperature, and therefore, some water is lost because of evaporation. Based on conservative estimates, NRC estimates that this induced evaporation resulting from the elevated discharge temperature would be less than 60 cfs (27,000 gpm or 1.7 m^3/s). This loss is about 0.5 percent of the annual average downstream flow of the Hudson River, which is more than 9000 cfs (4 million gpm or 255 m^3/s). The average cooling water transient time ranges from 5.6 minutes for the IP3 cooling water system to 9.7 minutes for the IP2 system. Auxiliary water systems for service water are also provided from the Hudson River via the dedicated bays in the IP2 and IP3 intake structures. The primary role of service water is to cool components (e.g., pumps) that generate heat during operation. Secondary functions of the service water include the following:

- protect equipment from potential contamination from river water by providing cooling to intermediate freshwater systems;

- provide water for washing the modified Ristroph traveling screens; and,
- provide seal water for the main circulating water pumps.

As noted above, additional service water is provided to the nonessential service water header for IP2 through the IP1 river water intake structure. The IP1 intake includes four intake bays each with a coarse bar screen and a single 0.125-in. (0.318-cm) mesh screen. The intake structure contains two 36-cfs[2] (16,000-gpm; 1.0-m^3/s) spray wash pumps. The screens are washed automatically and materials are sluiced to the Hudson River.

Comment [A3]: Question to NRC/Entergy – is this screen a Ristroph screen, modified Ristroph screen, or other type of screen? If the latter, please describe it.

Based on the description of the action provided in the FEIS, no major construction is proposed by Entergy during the relicensing period. Entergy may undertake some refurbishment activities. In the FEIS, NRC indicates that Entergy may replace the reactor vessel heads and control rod drive mechanisms (CRDMs) for IP2 and IP3 during the term of the renewed license. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). There would be no in-water work and there is no indication that effects of this refurbishment activity would extend to the Hudson River. As such, no shortnose or Atlantic sturgeon would be exposed to effects of this refurbishment activity; therefore, effects of this activity are not considered further in this Opinion.

3.4 Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." IP2 and IP3 are located on a 239-acre (97-hectare) site on the eastern bank of the Hudson River in the village of Buchanan, Westchester County, New York, about 43 miles (mi) (69 kilometers [km) north of the southern tip of Manhattan, New York (Figures 1 and 2). The direct and indirect effects of the Indian Point facility are related to the intake of water from the Hudson River and the discharge of heated effluent back into the Hudson River. The proposed action has the potential to affect shortnose and Atlantic sturgeon in several ways: impingement or entrainment of individual sturgeon at the intakes; altering the abundance or availability of potential prey items; and, altering the riverine environment through the discharge of heated effluent and other pollutants. Therefore, the action area for this consultation includes the intake areas of IP1 (for service water), IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3 as described in the Effects of the Action section below.

4.0 STATUS OF THE SPECIES

We have determined that the actions considered in the Opinion may adversely affect the following listed species:

Common name	Scientific name	ESA Status
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
GOM DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Threatened
New York Bight DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
Chesapeake Bay DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered

This section presents biological and ecological information relevant to formulating the Biological Opinion. Information on the species' life history, its habitat and distribution, and other factors necessary for its survival are included to provide background for analyses in later sections of this opinion. This section reviews the status of the species rangewide as well as the status of the species in the Hudson River where the action takes place.

4.1 Shortnose Sturgeon

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, isopods), insects, and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[3] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female and a mean of 11,568 eggs/kg body weight (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Dispersal rates differ at least regionally, laboratory studies on Connecticut River larvae indicated dispersal peaked 7-12 days

[3] For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

after hatching in comparison to Savannah River larvae that had longer dispersal rates with multiple, prolonged peaks, and a low level of downstream movement that continued throughout the entire larval and early juvenile period (Parker 2007). Synder (1988) and Parker (2007) considered individuals to be juvenile when they reached 57mm TL. Laboratory studies demonstrated that larvae from the Connecticut River made this transformation on day 40 while Savannah River fish made this transition on day 41 and 42 (Parker 2007).

The juvenile phase can be subdivided in to young of the year (YOY) and immature/ sub-adults. YOY and sub-adult habitat use differs and is believed to be a function of differences in salinity tolerances. Little is known about YOY behavior and habitat use, though it is believed that they are typically found in channel areas within freshwater habitats upstream of the salt wedge for about one year (Dadswell et al. 1984, Kynard 1997). One study on the stomach contents of YOY revealed that the prey items found corresponded to organisms that would be found in the channel environment (amphipods) (Carlson and Simpson 1987). Sub-adults are typically described as age one or older and occupy similar spatio-temporal patterns and habitat-use as adults (Kynard 1997). Though there is evidence from the Delaware River that sub-adults may overwinter in different areas than adults and do not form dense aggregations like adults (ERC Inc. 2007). Sub-adults feed indiscriminately; typical prey items found in stomach contents include aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Dadswell 1979, Carlson and Simpson 1987, Bain 1997).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures reach between 7-9.7ºC (44.6-49.5°F), pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 15º (46.4-59°F), and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell et al. 1984; Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984).

Between 8° (46.4°F) and 12°C (53.6°F), eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles or sub-adults tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes and move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney et al. 1992; Rogers et al. 1994; Rogers and Weber 1995; Weber 1996).

While shortnose sturgeon do not undertake the significant marine migrations seen in Atlantic sturgeon, telemetry data indicates that shortnose sturgeon do make localized coastal migrations. This is particularly true within certain areas such as the Gulf of Maine (GOM) and among rivers in the Southeast. Interbasin movements have been documented among rivers within the GOM and between the GOM and the Merrimack, between the Connecticut and Hudson rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F) (Dadswell et al. 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). However, water temperatures above 28ºC (82.4°F) are thought to adversely affect shortnose sturgeon. In the Altamaha River, water temperatures of 28-30ºC (82.4-86°F) during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. Dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m (approximately 2 feet) is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m (98.4 ft) but are generally found in waters less than 20m (65.5 ft) (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989); however, shortnose sturgeon forage on vegetated mudflats and over shellfish beds in shallower waters when suitable forage is present.

Status and Trends of Shortnose Sturgeon Rangewide
Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were "in peril…gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[4] of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such

4 The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (2005) also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, United States Geological Survey, personal communication; Dionne 2010), while the largest populations are found in the Saint John (~18, 000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species population rangewide, or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery rangewide

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel et al. 1992; Collins et al. 1996). In-water or nearshore construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to riverine habitat which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e. PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC. Flourney et al.(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney et al.1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (82.4°F) (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

4.2 Atlantic Sturgeon

The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon and then provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of which Atlantic sturgeon

DPSs likely occur in the action area and provide information on the use of the action area by Atlantic sturgeon.

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott, 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). NMFS has delineated U.S. populations of Atlantic sturgeon into five DPSs (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (see Figure 1). The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King, 2011). However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine and riverine environment that occur far from natal spawning rivers.

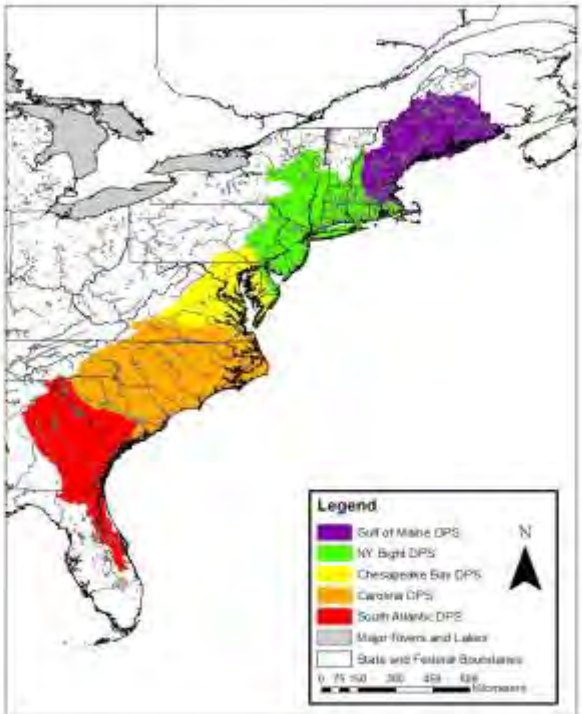
On February 6, 2012, we published notice in the *Federal Register* that we were listing the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs as endangered, and the Gulf of Maine DPS as threatened (77 FR 5880 and 77 FR 5914). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings.

As described below, individuals originating from three of the five listed DPSs may occur in the action area. Information general to all Atlantic sturgeon as well as information specific to each of the relevant DPSs, is provided below.

4.2.1 Determination of DPS Composition in the Action Area

As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated. We have determined that Atlantic sturgeon in the action area likely originate from three of the five DPSs at the following frequencies: Gulf of Maine 6%; NYB 92%; and, Chesapeake Bay 2%. These percentages are based on genetic sampling of individuals (n=39) captured within the Hudson River and therefore, represent the best available information on the likely genetic makeup of individuals occurring in the action area. The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation we have selected the reported values above, which approximate the mid-point of the range, as a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail in Damon-Randall *et al.* (2012a).

Figure 1. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs



4.2.2 Atlantic sturgeon life history

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[5] fish (Bigelow and Schroeder, 1953; Vladykov and Greeley 1963; Mangin, 1964; Pikitch *et al.*, 2005; Dadswell, 2006; ASSRT, 2007).

The life history of Atlantic sturgeon can be divided up into five general categories as described in the table below (adapted from ASSRT 2007).

[5] Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn (NEFSC FAQ's, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011)

Age Class	Size	Description
Egg		Fertilized or unfertilized
Larvae		Negative photo-taxic, nourished by yolk sac
Young of Year (YOY)	**0.3 grams <41 cm TL**	Fish that are > 3 months and < one year; capable of capturing and consuming live food
Non-migrant subadults or juveniles	**>41 cm and <76 cm TL**	Fish that are at least age 1 and are not sexually mature and do not make coastal migrations.
Subadults	**>76cm and <150cm TL**	Fish that are not sexually mature but make coastal migrations
Adults	**>150 cm TL**	Sexually mature fish

Table 1. Descriptions of Atlantic sturgeon life history stages.

Atlantic sturgeon are a relatively large fish, even amongst sturgeon species (Pikitch *et al.*, 2005). Atlantic sturgeons are bottom feeders that suck food into a ventrally-located protruding mouth (Bigelow and Schroeder, 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder, 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007; Savoy, 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007).

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e. length) than fully mature males; and (4) the length of Atlantic sturgeon caught since the mid-late 20th century have typically been less than 3 meters (m) (Smith *et al.*, 1982; Smith *et al.*, 1984; Smith, 1985; Scott and Scott, 1988; Young *et al.*, 1998; Collins *et al.*, 2000; Caron *et al.*, 2002; Dadswell, 2006; ASSRT, 2007; Kahnle *et al.*, 2007; DFO, 2011).

The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 m (Vladykov and Greeley, 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large-sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Dadswell, 2006). However, while females are prolific with egg production ranging from 400,000 to 4 million eggs per spawning year, females spawn at intervals of 2-5 years (Vladykov and Greeley, 1963; Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Stevenson and Secor, 1999; Dadswell, 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman, 1997). Males exhibit spawning periodicity of 1-5 years (Smith, 1985; Collins *et al.*, 2000; Caron *et al.*, 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (ASMFC, 2009). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco, 1977; Smith, 1985; Bain, 1997; Smith and Clugston, 1997; Caron *et al.*, 2002). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43° F) (Smith *et al.*, 1982; Dovel and Berggren, 1983; Smith, 1985; ASMFC, 2009), and remain on the spawning grounds throughout the spawning season (Bain, 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren, 1983; Smith, 1985; Collins *et al.*, 2000), make rapid spawning migrations upstream, and quickly depart following spawning (Bain, 1997).

The spawning areas in most U.S. rivers have not been well defined. However, the habitat characteristics of spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 cm/s and depths are 3-27 m (Borodin, 1925; Dees, 1961; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; Shirey *et al.* 1999; Bain *et al.*, 2000; Collins *et al.*, 2000; Caron *et al.* 2002; Hatin *et al.* 2002; ASMFC, 2009). Sturgeon eggs are deposited on hard bottom substrate such as cobble, coarse sand, and bedrock (Dees, 1961; Scott and Crossman, 1973; Gilbert, 1989; Smith and Clugston, 1997; Bain *et al.* 2000; Collins *et al.*, 2000; Caron *et al.*, 2002; Hatin *et al.*, 2002; Mohler, 2003; ASMFC, 2009), and become adhesive shortly after fertilization (Murawski and Pacheco, 1977; Van den Avyle, 1983; Mohler, 2003). Incubation time for the eggs increases as water temperature decreases (Mohler, 2003). At temperatures of 20° and 18° C, hatching occurs approximately 94 and 140 hours, respectively, after egg deposition (ASSRT, 2007).

Larval Atlantic sturgeon (i.e. less than 4 weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam *et al.* 1996) are assumed to undertake a demersal existence and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.*, 1980; Bain *et al.*, 2000; Kynard and Horgan, 2002; ASMFC, 2009). Studies suggest that age-0 (i.e., young-of-year), age-1, and age-2 juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley, 1999; Hatin *et al.*, 2007; McCord *et al.*, 2007; Munro *et al.*, 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.*, 2000). Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton, 1973; Dovel and Berggen, 1983; Waldman *et al.*, 1996; Dadswell, 2006; ASSRT, 2007).

After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 m in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley, 1963; Murawski and Pacheco, 1977; Dovel and Berggren, 1983; Smith, 1985; Collins and Smith, 1997; Welsh *et al.*, 2002; Savoy and Pacileo, 2003; Stein *et al.*, 2004; USFWS, 2004; Laney *et al.*, 2007; Dunton *et al.*, 2010; Erickson *et al.*, 2011; Wirgin and King, 2011). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 m during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 m in summer and fall (Erickson *et al.*, 2011). Shirey (Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009) found a similar movement pattern for juvenile Atlantic sturgeon based on recaptures of fish originally tagged in the Delaware River. After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras, North Carolina from November through early March. In the spring, a portion of the tagged fish re-entered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall. The majority of these tag returns were reported from relatively shallow near shore fisheries with few fish reported from waters in excess of 25 m (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia/North Carolina border to Cape Hatteras at depths up to 24 m (Dovel and Berggren, 1983; Dadswell *et al.*, 1984; Johnson *et al.*, 1997; Rochard *et al.*, 1997; Kynard *et al.*, 2000; Eyler *et al.*, 2004; Stein *et al.*, 2004; Wehrell, 2005; Dadswell, 2006; ASSRT, 2007; Laney *et al.*, 2007). These sites may be used as foraging sites and/or thermal refuge.

4.1.2 Distribution and Abundance

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and Crossman, 1973; Taub, 1990; Kennebec River Resource Management Plan, 1993; Smith and Clugston, 1997; Dadswell, 2006; ASSRT, 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware, and at least 10,000 females for other spawning stocks (Secor and Waldman, 1999; Secor, 2002). Historical records suggest that Atlantic sturgeon spawned in at least 35 rivers prior to this period. Currently, only 16 U.S. rivers are known to support spawning based on available evidence (i.e., presence of young-of-year or gravid Atlantic sturgeon documented within the past 15 years)

(ASSRT, 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only four rivers (Kennebec, Hudson, Delaware, James) are known to currently support spawning from Maine through Virginia where historical records support there used to be fifteen spawning rivers (ASSRT, 2007). Thus, there are substantial gaps in the range between Atlantic sturgeon spawning rivers amongst northern and mid-Atlantic states which could make recolonization of extirpated populations more difficult.

There are no current, published population abundance estimates for any spawning stock or for any of the five DPSs of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). An estimate of 343 spawning adults per year is available for the Altamaha River, GA, based on fishery-independent data collected in 2004 and 2005 (Schueller and Peterson, 2006). Using the data collected from the Hudson River and Altamaha River to estimate the total number of Atlantic sturgeon in either subpopulation is not possible, since mature Atlantic sturgeon may not spawn every year (Vladykov and Greeley, 1963; Smith, 1985; Van Eenennaam *et al.*, 1996; Stevenson and Secor, 1999; Collins *et al.* 2000; Caron *et al.*, 2002), the age structure of these populations is not well understood, and stage to stage survival is unknown. In other words, the information that would allow us to take an estimate of annual spawning adults and expand that estimate to an estimate of the total number of individuals (e.g., yearlings, subadults, and adults) in a population is lacking. The ASSRT presumed that the Hudson and Altamaha rivers had the most robust of the remaining U.S. Atlantic sturgeon spawning populations and concluded that the other U.S. spawning populations were likely less than 300 spawning adults per year (ASSRT, 2007).

4.1.3 Threats faced by Atlantic sturgeon throughout their range

Atlantic sturgeon are susceptible to over exploitation given their life history characteristics (e.g., late maturity, dependence on a wide-variety of habitats). Similar to other sturgeon species (Vladykov and Greeley, 1963; Pikitch *et al.*, 2005), Atlantic sturgeon experienced range-wide declines from historical abundance levels due to overfishing (for caviar and meat) and impacts to habitat in the 19th and 20th centuries (Taub, 1990; Smith and Clugston, 1997; Secor and Waldman, 1999).

Based on the best available information, NMFS has concluded that unintended catch of Atlantic sturgeon in fisheries, vessel strikes, poor water quality, water availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon (77 FR 5880 and 77 FR 5914; February 6, 2012). While all of the threats are not necessarily present in the same area at the same time, given that Atlantic sturgeon subadults and adults use ocean waters from the Labrador, Canada to Cape Canaveral, FL, as well as estuaries of large rivers along the U.S. East Coast, activities affecting these water bodies are likely to impact more than one Atlantic sturgeon DPS. In addition, given that Atlantic sturgeon depend on a variety of habitats, every life stage is likely affected by one or more of the identified threats.

An ASMFC interstate fishery management plan for sturgeon (Sturgeon FMP) was developed and implemented in 1990 (Taub, 1990). In 1998, the remaining Atlantic sturgeon fisheries in U.S. state waters were closed per Amendment 1 to the Sturgeon FMP. Complementary regulations were implemented by NMFS in 1999 that prohibit fishing for, harvesting, possessing or retaining Atlantic sturgeon or its parts in or from the Exclusive Economic Zone in the course of a commercial fishing activity.

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters (DFO, 2011). Sturgeon belonging to one or more of the DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the Gulf of Maine and the New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO, 2010; Wirgin and King, 2011). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), the U.S. and Canada are currently working on a conservation strategy to address the potential for captures of U.S. fish in Canadian directed Atlantic sturgeon fisheries and of Canadian fish incidentally in U.S. commercial fisheries. At this time, there are no estimates of the number of individuals from any of the DPSs that are captured or killed in Canadian fisheries each year.

Based on geographic distribution, most U.S. Atlantic sturgeon that are intercepted in Canadian fisheries are likely to originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Individuals from all 5 DPSs are caught as bycatch in fisheries operating in U.S. waters. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Federal FMPs (NMFS NEFSC 2011) in the Northeast Region but do not have a similar estimate for Southeast fisheries. We also do not have an estimate of the number of Atlantic sturgeon captured or killed in state fisheries. At this time, we are not able to quantify the effects of other significant threats (e.g., vessel strikes, poor water quality, water availability, dams, and dredging) in terms of habitat impacts or loss of individuals. While we have some information on the number of mortalities that have occurred in the past in association with certain activities (e.g., mortalities in the Delaware and James rivers that are thought to be due to vessel strikes), we are not able to use those numbers to extrapolate effects throughout one or more DPS. This is because of (1) the small number of data points and, (2) lack of information on the percent of incidences that the observed mortalities represent.

As noted above, the NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by Northeast FMPs (NEFSC 2011). The analysis prepared by the NEFSC estimates that from 2006 through 2010 there were 2,250 to 3,862 encounters per year in observed gillnet and trawl fisheries, with an average of 3,118 encounters. Mortality rates in gillnet gear are approximately 20%. Mortality rates in otter trawl gear are believed to be lower at approximately 5%.

4.2 Gulf of Maine DPS of Atlantic sturgeon

The Gulf of Maine DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007). Spawning still occurs in the Kennebec River, and it is possible that it still occurs in the Penobscot River as well. Spawning in the Androscoggin River was just recently confirmed by the Maine Department of Marine Resources when they captured a larval Atlantic sturgeon during the 2011 spawning season below the Brunswick Dam. There is no evidence of recent spawning in the remaining rivers. In the 1800s, construction of the Essex Dam on the Merrimack River at river kilometer (rkm) 49 blocked access to 58 percent of Atlantic sturgeon habitat in the river (Oakley, 2003; ASSRT, 2007). However, the accessible portions of the Merrimack seem to be suitable habitat for Atlantic sturgeon spawning and rearing (i.e., nursery habitat) (Keiffer and Kynard, 1993). Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in the Merrimack River. Studies are on-going to determine whether Atlantic sturgeon are spawning in these rivers. Atlantic sturgeons that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT, 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the Gulf of Maine DPS as well as likely throughout the entire range (ASSRT, 2007; Fernandes, *et al.*, 2010).

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (Squiers *et al.*, 1981; ASMFC, 1998; NMFS and USFWS, 1998). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (i.e., expressing milt) in July 1994 below the (former) Edwards Dam; (2) capture of 31 adult Atlantic sturgeon from June 15,1980, through July 26,1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least 4 ripe males and 1 ripe female captured on July 26,1980; and, (3) capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (NMFS and USFWS, 1998; ASMFC 2007). The low salinity values for waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

Several threats play a role in shaping the current status of Gulf of Maine DPS Atlantic sturgeon. Historical records provide evidence of commercial fisheries for Atlantic sturgeon in the Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers *et al.*, 1979). In 1849, 160 tons of sturgeon was caught in the Kennebec River by local fishermen (Squiers *et al.*, 1979). Following the 1880's, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. All directed Atlantic sturgeon fishing as well as retention of Atlantic sturgeon by-catch has been prohibited since 1998. Nevertheless, mortalities associated with bycatch in fisheries occurring in state and federal waters still occurs. In the marine range, Gulf of Maine DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Many rivers in the Gulf of Maine DPS have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine DPS. While some dredging projects operate with observers present to document fish mortalities, many do not. To date we have not received any reports of Atlantic sturgeon killed during dredging projects in the Gulf of Maine region; however, as noted above, not all projects are monitored for interactions with fish. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects. We are also not able to quantify any effects to habitat.

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin and Saco Rivers, these dams are near the site of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon are known to occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. While not expected to be killed or injured during passage at a dam, the extent that Atlantic sturgeon are affected by the existence of dams and their operations in the Gulf of Maine region is currently unknown. The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown; however, the documentation of an Atlantic sturgeon larvae downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie and Great Works Dams. Together these dams prevent Atlantic sturgeon from accessing approximately 29 km of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. While removal of the Veazie and Great Works Dams is anticipated to occur in the near future, the presence of these dams is currently preventing access to significant habitats within the Penobscot River. While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie and Great Works Dams affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

Gulf of Maine DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Gulf of Maine over the past decades (Lichter *et al.* 2006; EPA, 2008). Many rivers in Maine, including the Androscoggin River, were heavily polluted in the past from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

There are no empirical abundance estimates for the Gulf of Maine DPS. The Atlantic sturgeon SRT (2007) presumed that the Gulf of Maine DPS was comprised of less than 300 spawning adults per year, based on abundance estimates for the Hudson and Altamaha River riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers, 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized, adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies.

Summary of the Gulf of Maine DPS
Spawning for the Gulf of Maine DPS is known to occur in two rivers (Kennebec and Androscoggin) and possibly in a third. Spawning may be occurring in other rivers, such as the Sheepscot or Penobscot, but has not been confirmed. There are indications of increasing abundance of Atlantic sturgeon belonging to the Gulf of Maine DPS. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River, and are observed in rivers where they were unknown to occur or had not been observed to occur for many years (e.g., the Saco, Presumpscot, and Charles rivers). These observations suggest that abundance of the Gulf of Maine DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for this DPS.

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC, 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy.(Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). NMFS has determined that the Gulf of Maine DPS is at risk of becoming endangered in the foreseeable future throughout all of its range (i.e., is a threatened species) based on the following: (1) significant declines in population sizes and the protracted period during which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect recovery.

4.3 New York Bight DPS of Atlantic sturgeon

The New York Bight DPS includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, MA to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco, 1977; Secor, 2002; ASSRT, 2007). Spawning still occurs in the Delaware and Hudson Rivers, but there is no recent evidence (within the last 15 years) of spawning in the Connecticut and Taunton Rivers (ASSRT, 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT, 2007; Savoy, 2007; Wirgin and King, 2011).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800's is unknown but, has been conservatively estimated at 10,000 adult females (Secor, 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor, 2002; ASSRT, 2007; Kahnle *et al.*, 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). Kahnle *et al.* (1998; 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid 1970s (Kahnle *et al.*, 1998). A decline appeared to occur in the mid to late 1970s followed by a secondary drop in the late 1980s (Kahnle *et al.*, 1998; Sweka *et al.*, 2007; ASMFC, 2010). Catch-per-unit-effort data suggests that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980's (Sweka *et al.*, 2007; ASMFC, 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and while the CPUE is generally higher in the 2000s as compared to the 1990s. Given the significant annual fluctuation, it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s. There is currently not enough information regarding any life stage to establish a trend for the Hudson River population.

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800s indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman, 1999; Secor, 2002). Sampling in 2009 to target young-of- the year (YOY) Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 YOY, ranging in size from 178 to 349 mm TL (Fisher, 2009) and the collection of 32 YOY Atlantic sturgeon in a separate study (Brundage and O'Herron in Calvo *et al.*, 2010). Genetics information collected from 33 of the 2009 year class YOY indicates that at least 3 females successfully contributed to the 2009 year class (Fisher, 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning is still occurring in the Delaware River, the relatively low numbers suggest the existing riverine population is limited in size.

Several threats play a role in shaping the current status and trends observed in the Delaware River and Estuary. In-river threats include habitat disturbance from dredging, and impacts from historical pollution and impaired water quality. A dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron, 2009), and the river receives significant shipping traffic. Vessel strikes have been identified as a threat in the Delaware River; however, at this time we do not have information to quantify this threat or its impact to the population or the New York Bight DPS. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population.

Summary of the New York Bight DPS
Atlantic sturgeon originating from the New York Bight DPS spawn in the Hudson and Delaware rivers. While genetic testing can differentiate between individuals originating from the Hudson or Delaware river the available information suggests that the straying rate is high between these rivers. There are no indications of increasing abundance for the New York Bight DPS (ASSRT, 2009; 2010). Some of the impact from the threats that contributed to the decline of the New York Bight DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes remain significant threats to the New York Bight DPS.

In the marine range, New York Bight DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, currently available estimates indicate that at least 4% of adults may be killed as a result of bycatch in fisheries authorized under Northeast FMPs. Based on mixed stock analysis results presented by Wirgin and King (2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the New York Bight DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the New York Bight DPS. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects are also not able to quantify any effects to habitat.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the New York Bight region is currently unknown.

New York Bight DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006; EPA, 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

Vessel strikes occur in the Delaware River. Twenty-nine mortalities believed to be the result of vessel strikes were documented in the Delaware River from 2004 to 2008, and at least 13 of these fish were large adults. Given the time of year in which the fish were observed (predominantly May through July, with two in August), it is likely that many of the adults were migrating through the river to the spawning grounds. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the New York Bight DPS.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the New York Bight DPS. NMFS has determined that the New York Bight DPS is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect population recovery.

4.4 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, VA. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT, 2007). Based on the review by Oakley (2003), 100 percent of Atlantic sturgeon habitat is currently accessible in these rivers since most of the barriers to passage (i.e. dams) are located upriver of where spawning is expected to have historically occurred (ASSRT, 2007). Spawning still occurs in the James River, and the presence of juvenile and adult sturgeon in the York River suggests that spawning may occur there as well (Musick *et* *al.*, 1994; ASSRT, 2007; Greene, 2009). However, conclusive evidence of current spawning is only available for the James River. Atlantic sturgeon that are spawned elsewhere are known to use the Chesapeake Bay for other life functions, such as foraging and as juvenile nursery habitat prior to entering the marine system as subadults (Vladykov and Greeley, 1963; ASSRT, 2007; Wirgin *et al.*, 2007; Grunwald *et al.*, 2008).

Age to maturity for Chesapeake Bay DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is 5 to 19 years for Atlantic sturgeon originating from South Carolina rivers (Smith *et al.*, 1982) and 11 to 21 years for Atlantic sturgeon originating from the Hudson River (Young *et al.*, 1998). Therefore, age at maturity for Atlantic sturgeon of the Chesapeake Bay DPS likely falls within these values.

Several threats play a role in shaping the current status of Chesapeake Bay DPS Atlantic sturgeon. Historical records provide evidence of the large-scale commercial exploitation of Atlantic sturgeon from the James River and Chesapeake Bay in the 19th century (Hildebrand and Schroeder, 1928; Vladykov and Greeley, 1963; ASMFC, 1998; Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007) as well as subsistence fishing and attempts at commercial fisheries as early as the 17th century (Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007; Balazik *et al.*, 2010). Habitat disturbance caused by in-river work such as dredging for navigational purposes is thought to have reduced available spawning habitat in the James River (Holton and Walsh, 1995; Bushnoe *et al.*, 2005; ASSRT, 2007). At this time, we do not have information to quantify this loss of spawning habitat.

Decreased water quality also threatens Atlantic sturgeon of the Chesapeake Bay DPS, especially since the Chesapeake Bay system is vulnerable to the effects of nutrient enrichment due to a relatively low tidal exchange and flushing rate, large surface to volume ratio, and strong stratification during the spring and summer months (Pyzik *et al.*, 2004; ASMFC, 1998; ASSRT, 2007; EPA, 2008). These conditions contribute to reductions in dissolved oxygen levels throughout the Bay. The availability of nursery habitat, in particular, may be limited given the recurrent hypoxia (low dissolved oxygen) conditions within the Bay (Niklitschek and Secor, 2005; 2010). At this time we do not have sufficient information to quantify the extent that degraded water quality effects habitat or individuals in the James River or throughout the Chesapeake Bay.

Vessel strikes have been observed in the James River (ASSRT, 2007). Eleven Atlantic sturgeon were reported to have been struck by vessels from 2005 through 2007. Several of these were mature individuals. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the New York Bight DPS.

In the marine and coastal range of the Chesapeake Bay DPS from Canada to Florida, fisheries bycatch in federally and state managed fisheries pose a threat to the DPS, reducing survivorship of subadults and adults and potentially causing an overall reduction in the spawning population

(Stein *et al.*, 2004; ASMFC, 2007; ASSRT, 2007).

Summary of the Chesapeake Bay DPS
Spawning for the Chesapeake Bay DPS is known to occur in only the James River. Spawning may be occurring in other rivers, such as the York, but has not been confirmed. There are anecdotal reports of increased sightings and captures of Atlantic sturgeon in the James River. However, this information has not been comprehensive enough to develop a population estimate for the James River or to provide sufficient evidence to confirm increased abundance. Some of the impact from the threats that facilitated the decline of the Chesapeake Bay DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). We do not currently have enough information about any life stage to establish a trend for this DPS.

Areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in U.S. state and federally-managed fisheries, Canadian fisheries and vessel strikes remain significant threats to the Chesapeake Bay DPS of Atlantic sturgeon. Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007). The Chesapeake Bay DPS is currently at risk of extinction given (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect the potential for population recovery.

4.5 Shortnose Sturgeon in the Hudson River and the action area

The action area is limited to the reach of the Hudson River affected by the operations of IP2 and IP3, including IP1 to the extent its water intake services IP2, as described in the "Action Area" section above. As such, this section will discuss the available information related to the presence and status of shortnose sturgeon in the Hudson River and in the action area.

Shortnose sturgeon were first observed in the Hudson River by early settlers who captured them as a source of food and documented their abundance (Bain et al. 1998). Shortnose sturgeon in the Hudson River were documented as abundant in the late 1880s (Ryder 1888 in Hoff 1988). Prior to 1937, a few fishermen were still commercially harvesting shortnose sturgeon in the Hudson River; however, fishing pressure declined as the population decreased. During the late 1800s and early 1900s, the Hudson River served as a dumping ground for pollutants that lead to major oxygen depletions and resulted in fish kills and population reductions. During this same time there was a high demand for shortnose sturgeon eggs (caviar), leading to overharvesting. Water pollution, overfishing, and the commercial Atlantic sturgeon fishery are all factors that may have contributed to the decline of shortnose sturgeon in the Hudson River (Hoff 1988).

In the 1930s, the New York State Biological Survey launched the first scientific analysis that documented the distribution, age, and size of mature shortnose sturgeon in the Hudson River (see Bain et al. 1998). In the 1970s, scientific sampling resumed precipitated by the lack of biological data and concerns about the impact of electric generation facilities on fishery resources (see Bain et al. 1998). The current population of shortnose sturgeon has been documented by studies conducted throughout the entire range of shortnose sturgeon in the Hudson River (see: Dovel 1979, Hoff et al. 1988, Geoghegan et al. 1992, Bain et al. 1998, Bain et al. 2000, Dovel et al. 1992).

Several population estimates were conducted throughout the 1970s and 1980s (Dovel 1979; Dovel 1981; Dovel et al. 1992). Most recently, Bain et al. (1998) conducted a mark recapture study from 1994 through 1997 focusing on the shortnose sturgeon active spawning stock. Utilizing targeted and dispersed sampling methods, 6,430 adult shortnose sturgeon were captured and 5,959 were marked; several different abundance estimates were generated from this sampling data using different population models. Abundance estimates generated ranged from a low of 25, 255 to a high of 80,026; though 61,057 is the abundance estimate from this dataset and modeling exercise that is typically used. This estimate includes spawning adults estimated to comprise 93% of the entire population or 56,708, non-spawning adults accounting for 3% of the population and juveniles 4% (Bain et al. 2000). Bain et al. (2000) compared the spawning population estimate with estimates by Dovel et al. (1992) concluding an increase of approximately 400% between 1979 and 1997. Although fish populations dominated by adults are not common for most species, there is no evidence that this is atypical for shortnose sturgeon (Bain et al. 1998).

Woodland and Secor (2007) examined the Bain et al. (1998, 2000, 2007) estimates to try and identify the cause of the major change in abundance. Woodland and Secor (2007) concluded that the dramatic increase in abundance was likely due to improved water quality in the Hudson River which allowed for high recruitment during years when environmental conditions were right, particularly between 1986-1991. These studies provide the best information available on the current status of the Hudson River population and suggests that the population is relatively healthy, large, and particular in habitat use and migratory behavior (Bain et al. 1998).

Shortnose sturgeon have been documented in the Hudson River from upper Staten Island (RM -3 (rkm -4.8)) to the Troy Dam (RM 155 (rkm 249.5); for reference, Indian Point is located at RM 43 (rkm 69))[6] (Bain et al. 2000, ASA 1980-2002). Prior to the construction of the Troy Dam in 1825, shortnose sturgeon are thought to have used the entire freshwater portion of the Hudson River (NYHS 1809). Spawning fish congregated at the base of Cohoes Falls where the Mohawk River emptied into the Hudson. In recent years (since 1999), shortnose sturgeon have been documented below the Tappan Zee Bridge from June through December (ASA 1999-2002; Dynegy 2003). While shortnose sturgeon presence below the Tappan Zee Bridge had previously been thought to be rare (Bain et al. 2000), increasing numbers of shortnose sturgeon have been documented in this area over the last several years (ASA 1999-2002; Dynegy 2003) suggesting that the range of shortnose sturgeon is extending downstream. Shortnose sturgeon were documented as far south as the Manhattan/Staten Island area in June, November and December 2003 (Dynegy 2003).

From late fall to early spring, adult shortnose sturgeon concentrate in a few overwintering areas. Reproductive activity the following spring determines overwintering behavior. The largest overwintering area is just south of Kingston, NY, near Esopus Meadows (RM 86-94, rkm 139-152) (Dovel et al. 1992). The fish overwintering at Esopus Meadows are mainly spawning adults. Recent capture data suggests that these areas may be expanding (Hudson River 1999-

---

6 See Figure 3 for a map of the Hudson River with these areas highlighted.

2002, Dynegy 2003). Captures of shortnose sturgeon during the fall and winter from Saugerties to Hyde Park (greater Kingston reach), indicate that additional smaller overwintering areas may be present (Geoghegan et al. 1992). Both Geoghegan et al. (1992) and Dovel et al. (1992) also confirmed an overwintering site in the Croton-Haverstraw Bay area (RM 33.5 – 38,rkm 54-61). The Indian Point facility is located approximately 8km (5 miles) north of the northern extent of this overwintering area, which is near rkm 61 (RM 38). Fish overwintering in areas below Esopus Meadows are mainly thought to be pre-spawning adults. Typically, movements during overwintering periods are localized and fairly sedentary.

In the Hudson River, males usually spawn at approximately 3-5 years of age while females spawn at approximately 6-10 years of age (Dadswell et al. 1984; Bain et al. 1998). Males may spawn annually once mature and females typically spawn every 3 years (Dovel et al. 1992). Mature males feed only sporadically prior to the spawning migration, while females do not feed at all in the months prior to spawning.

In approximately late March through mid-April, when water temperatures are sustained at 8º-9° C (46.4-48.2°F) for several days[7], reproductively active adults begin their migration upstream to the spawning grounds that extend from below the Federal Dam at Troy to about Coeymans, NY (rkm 245-212 (RM 152-131); located more than 150km (93 miles) upstream from the Indian Point facility) (Dovel et al. 1992). Spawning typically occurs at water temperatures between 10-18°C (50-64.4°F) (generally late April-May) after which adults disperse quickly down river into their summer range. Dovel et al. (1992) reported that spawning fish tagged at Troy were recaptured in Haverstraw Bay in early June. The broad summer range occupied by adult shortnose sturgeon extends from approximately rkm 38 to rkm 177 (RM 23.5-110). The Indian Point facility (at rkm 69) is located within the broad summer range.

There is scant data on actual collection of early life stages of shortnose sturgeon in the Hudson River. During a mark recapture study conducted from 1976-1978, Dovel et al. (1979) captured larvae near Hudson, NY (rkm 188, RM 117) and young of the year were captured further south near Germantown (RM 106, rkm 171). Between 1996 and 2004, approximately 10 small shortnose sturgeon were collected each year as part of the Falls Shoals Survey (FSS) (ASA 2007). Based upon basic life history information for shortnose sturgeon it is known that eggs adhere to solid objects on the river bottom (Buckley and Kynard 1981; Taubert 1980) and that eggs and larvae are expected to be present within the vicinity of the spawning grounds (rkm 245-212, RM 152-131) for approximately four weeks post spawning (i.e., at latest through mid-June). Shortnose sturgeon larvae in the Hudson River generally range in size from 15 to 18 mm (0.6-0.7 inches) TL at hatching (Pekovitch 1979). Larvae gradually disperse downstream after hatching, entering the tidal river (Hoff et al. 1988). Larvae or fry are free swimming and typically concentrate in deep channel habitat (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer ad Kynard 1993). Given that fry are free swimming and foraging, they typically disperse downstream of spawning/rearing areas. Larvae can be found upstream of the salt wedge in the Hudson River estuary and are most commonly found in deep waters with strong currents,

[7] Based on information from the USGS gage in Albany (gage no. 01359139), in 2002 mean water temperatures reached 8ºC on April 10 and 15ºC on April 20; 2003 - 8ºC on April 14 and 15ºC on May 19; 2004 - 8ºC on April 17 and 15ºC on May 11. In 2011, water temperatures reached 8°C on April 11 and reached 15°C on May 19. In 2012, water temperatures reached 8°C on March 20 and reached 15°C on May 13.

typically in the channel (Hoff et al. 1988; Dovel et al. 1992). Larvae are not tolerant of saltwater and their occurrence within the estuary is limited to freshwater areas. The transition from the larval to juvenile stage generally occurs in the first summer of life when the fish grows to approximately 2 cm (0.8 in) TL and is marked by fully developed external characteristics (Pekovitch 1979).

Similar to non-spawning adults, most juveniles occupy the broad region of Haverstraw Bay (rkm 55-64.4) RM 34-40; Indian Point is located near the northern edge of the bay) (Dovel et al. 1992; Geoghegan et al. 1992) by late fall and early winter. Migrations from the summer foraging areas to the overwintering grounds are triggered when water temperatures fall to 8°C (46.4°F) (NMFS 1998), typically in late November[8]. Juveniles are distributed throughout the mid-river region during the summer and move back into the Haverstraw Bay region during the late fall (Bain et al. 1998; Geoghegan et al. 1992; Haley 1998).

Shortnose sturgeon are bottom feeders and juveniles may use the protuberant snout to “vacuum” the river bottom. Curran & Ries (1937) described juvenile shortnose sturgeon from the Hudson River as having stomach contents of 85-95% mud intermingled with plant and animal material. Other studies found stomach contents of adults were solely food items, implying that feeding is more precisely oriented. The ventral protrusable mouth and barbells are adaptations for a diet of small live benthic animals. Juveniles feed on smaller and somewhat different organisms than adults. Common prey items are aquatic insects (chironomids), isopods, and amphipods. Unlike adults, mollusks do not appear to be an important part of the diet of juveniles (Bain 1997). As adults, their diet shifts strongly to mollusks (Curran & Ries 1937).

Telemetry data has been instrumental in informing the extent of shortnose sturgeon coastal migrations. Recent telemetry data from the Gulf of Maine indicate shortnose sturgeon in this region undertake significant coastal migrations between larger river systems and utilize smaller coastal river systems during these interbasin movements (Fernandes 2008; UMaine unpublished data). Some outmigration has been documented in the Hudson River, albeit at low levels in comparison to coastal movement documented in the Gulf of Maine and Southeast rivers. Two individuals tagged in 1995 in the overwintering area near Kingston, NY were later recaptured in the Connecticut River. One of these fish was at large for over two years and the other 8 years prior to recapture. As such, it is reasonable to expect some level of movement out of the Hudson into adjacent river systems; however, based on available information it is not possible to predict what percentage of adult shortnose sturgeon originating from the Hudson River may participate in coastal migrations.

4.6 Atlantic sturgeon in the Hudson River and the action area

Use of the river by Atlantic sturgeon has been described by several authors. The area around Hyde Park (approximately rkm134) has consistently been identified as a spawning area through scientific studies and historical records of the Hudson River sturgeon fishery (Dovel and

[8] In 2002, water temperatures at the USGS gage at Hastings-on-Hudson (No. 01376304; the farthest downstream gage on the river) fell to 8°C on November 23. In 2003, water temperatures at this gage fell to 8°C on November 29. In 2010, water temperatures at the USGS gage at West Point, NY (No. 01374019; currently the farthest downstream gage on the river) fell to 8°C on November 23. In 2011, water temperatures at the USGS gage at West Point, NY (No. 01374019) fell to 8°C on November 24. This gage ceased operations on March 1, 2012.

Berggren, 1983; Van Eenennaam *et al.*, 1996; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Habitat conditions at the Hyde Park site are described as freshwater year round with bedrock, silt and clay substrates and waters depths of 12-24 m (Bain *et al.*, 2000). Bain *et al.* (2000) also identified a spawning site at rkm 112 based on tracking data. The rkm 112 site, located to one side of the river, has clay, silt and sand substrates, and is approximately 21-27 m deep (Bain *et al.*, 2000).

Young-of-year (YOY) have been recorded in the Hudson River between rkm 60 and rkm 148, which includes some brackish waters; however, larvae must remain upstream of the salt wedge because of their low salinity tolerance (Dovel and Berggren, 1983; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Catches of immature sturgeon (age 1 and older) suggest that juveniles utilize the estuary from the Tappan Zee Bridge through Kingston (rkm 43- rkm 148) (Dovel and Berggren, 1983; Bain *et al.*, 2000). Seasonal movements are apparent with juveniles occupying waters from rkm 60 to rkm 107 during summer months and then moving downstream as water temperatures decline in the fall, primarily occupying waters from rkm 19 to rkm 74 (Dovel and Berggren, 1983; Bain *et al.*, 2000). Based on river-bottom sediment maps (Coch, 1986) most juvenile sturgeon habitats in the Hudson River have clay, sand, and silt substrates (Bain *et al.*, 2000). Newburgh and Haverstraw Bays in the Hudson River are areas of known juvenile sturgeon concentrations (Sweka *et al.*, 2007). Sampling in spring and fall revealed that highest catches of juvenile Atlantic sturgeon occurred during spring in soft-deep areas of Haverstraw Bay even though this habitat type comprised only 25% of the available habitat in the Bay (Sweka *et al.*, 2007). Overall, 90% of the total 562 individual juvenile Atlantic sturgeon captured during the course of this study (14 were captured more than once) came from Haverstraw Bay (Sweka *et al.*, 2007). At around 3 years of age, Hudson River juveniles exceeding 70 cm total length begin to migrate to marine waters (Bain *et al.*, 2000).

Atlantic sturgeon adults are likely to migrate through the action area in the spring as they move from oceanic overwintering sites to upstream spawning sites and then migrate back through the area as they move to lower reaches of the estuary or oceanic areas in the late spring and early summer. Atlantic sturgeon adults are most likely to occur in the action area from May – September. Tracking data from tagged juvenile Atlantic sturgeon indicates that during the spring and summer individuals are most likely to occur within rkm 60-170. During the winter months, juvenile Atlantic sturgeon are most likely to occur between rkm 19 and 74. This seasonal change in distribution may be associated with seasonal movements of the saltwedge and differential seasonal use of habitats.

Based on the available data, Atlantic sturgeon may be present in the action area year round. As explained above, Atlantic sturgeon in the action area are likely to have originated from the New York Bight DPS, Chesapeake Bay DPS and Gulf of Maine DPS, with the majority of individuals originating from the New York Bight DPS, and the majority of those individuals originating from the Hudson River.

4.7 Factors Affecting the Survival and Recovery of Shortnose and Atlantic sturgeon in the Hudson River

There are several activities that occur in the Hudson River that affect individual shortnose and Atlantic sturgeon. Impacts of activities that occur within the action area are considered in the "Environmental Baseline" section (Section 5.0, below). Activities that impact sturgeon in the Hudson River but do not necessarily overlap with the action area are discussed below.

4.7.1 Hudson River Power Plants

The mid-Hudson River provides cooling water to four large power plants: Indian Point Nuclear Generating Station, Roseton Generating Station (RM 66, rkm 107), Danskammer Point Generating Station (RM 66, rkm 107), and Bowline Point Generating Station (RM 33, rkm 52.8). All of these stations use once-through cooling. The Lovett Generating Station (RM 42, rkm 67) is no longer operating.

In 1998, Central Hudson Gas and Electric Corporation (CHGEC), the operator of the Roseton and Danskammer Point power plants initiated an application with us for an incidental take (ITP) permit under section 10(a)(1)(B) of the ESA.[9] As part of this process CHGEC submitted a Conservation Plan and application for a 10(a)(1)(B) incidental take permit that proposed to minimize the potential for entrainment and impingement of shortnose sturgeon at the Roseton and Danskammer Point power plants. These measures ensure that the operation of these plants will not appreciably reduce the likelihood of the survival and recovery of shortnose sturgeon in the wild. In addition to the minimization measures, a proposed monitoring program was implemented to assess the periodic take of shortnose sturgeon, the status of the species in the project area, and the progress on the fulfillment of mitigation requirements. In December 2000, Dynegy Roseton L.L.C. and Dynegy Danskammer Point L.L.C. were issued incidental take permit no. 1269 (ITP 1269). At the time the ITP was issued, Atlantic sturgeon were not listed under the ESA; therefore, the ITP does not address Atlantic sturgeon.

The ITP exempts the incidental take of two shortnose sturgeon at Roseton and four at Danskammer Point annually. This incidental take level is based upon impingement data collected from 1972-1998. NMFS determined that this level of take was not likely to reduce the numbers, distribution, or reproduction of the Hudson River population of shortnose sturgeon in a way that appreciably reduces the likelihood of shortnose sturgeon to survive and recover in the wild. Since the ITP was issued, the number of shortnose sturgeon impinged has been very low. Dynegy has indicated that this may be due in part to reduced operations at the facilities which results in significantly less water withdrawal and therefore, less opportunity for impingement. While historical monitoring reports indicate that a small number of sturgeon larvae were entrained at Danskammer, no sturgeon larvae have been observed in entrainment samples collected since the ITP was issued. While the ITP does not currently address Atlantic sturgeon, the number of interactions with Atlantic sturgeon at Roseton and Danskammer that have been reported to NMFS since the ITP became effective has been very low.

[9] CHGEC has since been acquired by Dynegy Danskammer L.L.C. and Dynegy Roseton L.L.C. (Dynegy), thus the current incidental take permit is held by Dynegy. ESA Section 9 prohibits take, among other things, without express authorization through a Section 10 permit or exemption through a Section 7 Incidental Take Statement.

4.7.2 Scientific Studies permitted under Section 10 of the ESA

The Hudson River population of shortnose and Atlantic sturgeon have been the focus of a prolonged history of scientific research. In the 1930s, the New York State Biological Survey launched the first scientific sampling study and documented the distribution, age, and size of mature shortnose sturgeon (Bain *et al.* 1998). In the early 1970s, research resumed in response to a lack of biological data and concerns about the impact of electric generation facilities on fishery resources (Hoff 1988). In an effort to monitor relative abundance, population status, and distribution, intensive sampling of shortnose sturgeon in this region has continued throughout the past forty years. Sampling studies targeting other species, including Atlantic sturgeon, also incidentally capture shortnose sturgeon.

There are currently three scientific research permits issued pursuant to Section 10(a)(1)(A) of the ESA that authorize research on sturgeon in the Hudson River. The activities authorized under these permits are presented below.

NYDEC holds a scientific research permit (#16439, which replaces their previously held permit #1547) authorizing the assessment of habitat use, population abundance, reproduction, recruitment, age and growth, temporal and spatial distribution, diet selectivity, and contaminant load of shortnose sturgeon in the Hudson River Estuary from New York Harbor (RKM 0) to Troy Dam (RKM 245). NYDEC is authorized to use gillnets and trawls to capture up to 240 and 2,340 shortnose sturgeon in year one through years three and four and five, respectively. Research activities include: capture; measure, weigh; tag with passive integrated transponder (PIT) tags and Floy tags, if untagged; and sample genetic fin clips. A first subset of fish will also be anesthetized and tagged with acoustic transmitters; a second subset will have fin rays sampled for age and growth analysis; and a third subset will have gastric contents lavaged for diet analysis, as well as blood samples taken for contaminants. The unintentional mortality of nine shortnose sturgeon is anticipated over the five year life of the permit. This permit expires on November 24, 2016.

In April 2012, NYDEC was issued a scientific research permit (#16436) which authorizes the capture, handling and tagging of Atlantic sturgeon in the Hudson River. NYDEC is authorized to capture 1,350 juveniles and 200 adults. The unintentional mortality of two juveniles is anticipated annually over the five year life of the permit. This permit expires on April 5, 2017.

A permit was issued to Dynegy[10] in 2007 (#1580, originally issued as #1254) to evaluate the life history, population trends, and spacio-temporal and size distribution of shortnose sturgeon collected during the annual Hudson River Biological Monitoring Program. This permit was recently reissued to Entergy in August 2012 as permit #17095; the permit will expire in 2017. The permit holders are authorized to capture up to 82 shortnose sturgeon adults/juveniles and 82 Atlantic sturgeon annually to measure, weigh, tag, photograph, and collect tissue samples for genetic analyses. Dynegy is also authorized to lethally take up to 40 larvae of each species annually. No lethal take of any juvenile, subadult or adult sturgeon is authorized.

[10] Permit 1580 was issued by NMFS to Dynegy on behalf of "other Hudson River Generators including Entergy Nuclear Indian Point 2, L.L.C., Entergy Nuclear Indian Point 3, L.L.C. and Mirant (now GenOn) Bowline, L.L.C."

4.7.3 Hudson River Navigation Project

The Hudson River navigation project authorizes a channel 600 feet wide, New York City to Kingston narrowing to 400 feet wide to 2,200 feet south of the Mall Bridge (Dunn Memorial Bridge) at Albany with a turning basin at Albany and anchorages near Hudson and Stuyvesant, all with depths of 32 feet in soft material and 34 feet in rock; then 27 feet deep and 400 feet wide to 900 feet south of the Mall Bridge (Dunn Memorial Bridge); then 14 feet deep and generally 400 feet wide, to the Federal Lock at Troy; and then 14 feet deep and 200 feet wide, to the southern limit of the State Barge Canal at Waterford; with widening at bends and widening in front of the cities of Troy and Albany to form harbors 12 feet deep. The total length of the existing navigation project (NYC to Waterford) is about 155 miles. The only portion of the channel that is regularly dredged is the North Germantown and Albany reaches. Dredging is scheduled at times of year when sturgeon are least likely to be in the dredged reaches; no interactions with sturgeon have been observed.

4.7.4 Tappan Zee Bridge Replacement Project

The U.S. Federal Highway Authority (FHWA), the New York Department of Transportation (DOT), the New York State Thruway Authority (NYSTA) are planning to replace the existing Tappan Zee Bridge. A Record of Decision was signed in September 2012 and construction may start as soon as Fall 2012. Construction is expected to take 5 years. We issued a Biological Opinion to FHWA, as the lead Federal agency, in June 2012. This Opinion concluded that the proposed bridge replacement project may adversely affect but was not likely to jeopardize the continued existence of shortnose sturgeon or any DPS of Atlantic sturgeon. The ITS included with the Opinion exempts the lethal take of 2 shortnose sturgeon and 2 Atlantic sturgeon (from the Gulf of Maine, New York Bight or Chesapeake Bay DPS), as well as the capture and injury of shortnose and Atlantic sturgeon from the Gulf of Maine, New York Bight and Chesapeake Bay DPS. Injury and mortality may occur as a result of exposure to underwater noise from pile driving or capture in the dredge bucket. FHWA carried out a pile installation demonstration project in spring 2012 and no injured or dead sturgeon were observed.

4.7.5 Other Federally Authorized Actions

We have completed several informal consultations on effects of in-water construction activities in the Hudson River and New York Harbor permitted by the U.S. Army Corps of Engineers (USACE). This includes several dock and pier projects. No interactions with shortnose or Atlantic sturgeon have been reported in association with any of these projects.

We have also completed several informal consultations on effects of private dredging projects permitted by the USACE. All of the dredging was with a mechanical dredge. No interactions with shortnose or Atlantic sturgeon have been reported in association with any of these projects.

4.7.6 State Authorized Fisheries

Atlantic and shortnose sturgeon may be vulnerable to capture, injury and mortality in fisheries occurring in state waters. Information on the number of sturgeon captured or killed in state fisheries is extremely limited and as such, efforts are currently underway to obtain more information on the numbers of sturgeon captured and killed in state water fisheries. We are currently working with the Atlantic States Marine Fisheries Commission (ASMFC) and the coastal states to assess the impacts of state authorized fisheries on sturgeon. We anticipate that some states are likely to apply for ESA section 10(a)(1)(B) Incidental Take Permits to cover their fisheries; however, to date, no applications have been submitted. Below, we discuss the different fisheries authorized by the states and any available information on interactions between these fisheries and sturgeon.

American Eel
American eel (*Anguilla rostrata*) is exploited in fresh, brackish and coastal waters from the southern tip of Greenland to northeastern South America. American eel fisheries are conducted primarily in tidal and inland waters. In the Hudson River, eels between 6 and 14 inches long may be kept for bait; no eels may be kept for food (due to potential PCB contamination). Eels are typically caught with hook and line or with eel traps and may also be caught with fyke nets. Sturgeon are not known to interact with the eel fishery.

Shad and River herring
Shad and river herring (blueback herring (*Alosa aestivalis*) and alewives (*Alosa pseudoharengus*)) are managed under an ASMFC Interstate Fishery Management Plan. In 2005, the ASMFC approved a coastwide moratorium on commercial and recreational fishing for shad. In May 2009, ASMFC adopted Amendment 2 to the ISFMP for Shad and River Herring, which closes all recreational and commercial fisheries unless each state can show its fisheries are sustainable. New York has submitted a Sustainable Fishing Plan that is currently under review. The plan prohibits the taking of river herring in any state waters, except for Hudson River stocks, for which it proposes partial closure in the tributaries and a five-year commercial gillnet fishery in the lower river. Although now closed, in the past this fishery was known to capture Atlantic and shortnose sturgeon.

Striped bass
Fishing for striped bass occurs within the Hudson River. Striped bass are managed by ASMFC through Amendment 6 to the Interstate FMP, which requires minimum sizes for the commercial and recreational fisheries, possession limits for the recreational fishery, and state quotas for the commercial fishery (ASMFC 2003). Under Addendum 2, the coastwide striped bass quota remains the same, at 70% of historical levels. Data from the Atlantic Coast Sturgeon Tagging Database (2000-2004) shows that the striped bass fishery accounted for 43% of Atlantic sturgeon recaptures; however, no information on the total number of Atlantic sturgeon caught by fishermen targeting striped bass is available. No information on interactions between shortnose sturgeon and the striped bass fishery is available; however, because shortnose sturgeon can be caught in hook and line fisheries as well as in otter trawls, if this gear is used in areas of the river and estuary where shortnose sturgeon are present, there could be some capture of shortnose and Atlantic sturgeon in this fishery.

4.7.7 Other Impacts of Human Activities in the Action Area

Impacts of Contaminants and Water Quality
Historically, shortnose sturgeon were rare in the lower Hudson River, likely as a result of poor water quality precluding migration further downstream. However, in the past several years, the water quality has improved and sturgeon have been found as far downstream as the

Manhattan/Staten Island area. It is likely that contaminants remain in the water and in the action area, albeit to reduced levels. Sewage, industrial pollutants and waterfront development has likely decreased the water quality in the action area. Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like sturgeon are particularly vulnerable. Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979).

Principal toxic chemicals in the Hudson River include pesticides and herbicides, heavy metals, and other organic contaminants such as PAHs and PCBs. Concentrations of many heavy metals also appear to be in decline and remaining areas of concern are largely limited to those near urban or industrialized areas. With the exception of areas near New York City, there currently does not appear to be a major concern with respect to heavy metals in the Hudson River, however metals could have previously affected sturgeon.

PAHs, which are products of incomplete combustion, most commonly enter the Hudson River as a result of urban runoff. As a result, areas of greatest concern are limited to urbanized areas, principally near New York City. The majority of individual PAHs of concern have declined during the past decade in the lower Hudson River and New York Harbor.

PCBs are the principal toxic chemicals of concern in the Hudson River. Primary inputs of PCBs in freshwater areas of the Hudson River are from the upper Hudson River near Fort Edward and Hudson Falls, New York. In the lower Hudson River, PCB concentrations observed are a result of both transport from upstream as well as direct inputs from adjacent urban areas. PCBs tend to be bound to sediments and also bioaccumulate and biomagnify once they enter the food chain. This tendency to bioaccumulate and biomagnify results in the concentration of PCBs in the tissue concentrations in aquatic-dependent organisms. These tissue levels can be many orders of magnitude higher than those observed in sediments and can approach or even exceed levels that pose concern over risks to the environment and to humans who might consume these organisms. PCBs can have serious deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). PCB's may also contribute to a decreased immunity to fin rot (Dovel *et al.* 1992). Large areas of the upper Hudson River are known to be contaminated by PCBs, and this is thought to account for the high percentage of shortnose sturgeon in the Hudson River exhibiting fin rot. Under a statewide toxics monitoring program, the NYSDEC analyzed tissues from four shortnose sturgeon to determine PCB concentrations. In gonadal tissues, where lipid percentages are highest, the average PCB concentration was 29.55 parts per million (ppm; Sloan 1981) and in all tissues ranged from 22.1 to 997.0 ppm. Dovel (1992) reported that more than 75% of the shortnose sturgeon captured in his study had severe incidence of fin rot. Given that Atlantic sturgeon have similar sensitivities to toxins as shortnose sturgeon it is reasonable to anticipate that Atlantic sturgeon have been similarly affected. In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). Manufactured Gas Product (MGP) waste, which is chemically similar to the coal tar deposits found in the Connecticut River, is known to occur at several sites within the Hudson River and this waste may have had similar effects on any sturgeon present in the action area over the years.

Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

Heavy usage of the Hudson River and development along the waterfront could have affected shortnose sturgeon throughout the action area. Coastal development and/or construction sites often result in excessive water turbidity, which could influence sturgeon spawning and/or foraging ability.

The Hudson River is used as a source of potable water, for waste disposal, transportation and cooling by industry and municipalities. Rohman *et al.* (1987) identified 183 separate industrial and municipal discharges to the Hudson and Mohawk Rivers. The greatest number of users were in the chemical industry, followed by the oil industry, paper and textile manufactures, sand, gravel, and rock processors, power plants, and cement companies. Approximately 20 publicly owned treatment works discharge sewage and wastewater into the Hudson River. Most of the municipal wastes receive primary and secondary treatment. A relatively small amount of sewage is attributed to discharges from recreational boats.

Water quality conditions in the Hudson River have dramatically improved since the mid-1970s. It is thought that this improvement may be a contributing factor to the improvement in the status of shortnose sturgeon in the river. However, as evidenced above, there are still concerns regarding the impacts of water quality on sturgeon in the river; particularly related to legacy contaminants for which no new discharges may be occurring, but environmental impacts are long lasting (e.g., PCBs, dioxins, coal tar, etc.)

5.0 ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area.

As described above, the action area is limited to the area where direct and indirect effects of the Indian Point facility are experienced and by definition is limited in the Hudson River to the intake areas of IP1 (for service water), IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3. The discussion below focuses on effects of state, federal or private actions, other than the action under consideration, that occur in the action area.

5.1 Federal Actions that have Undergone Formal or Early Section 7 Consultation
The only Federal actions that occur within the action area are the operations of the Indian Point facility and research activities authorized pursuant to Section 10 of the ESA (discussed above). No Federal actions that have undergone formal or early section 7 consultation occur in the action area.

Impacts of the Historical Operation of the Indian Point Facility
IP1 operated from 1962 through October 1974. IP2 and IP3 have been operational since 1973 and 1975, respectively. Since 1963, shortnose and Atlantic sturgeon in the Hudson River have been exposed to effects of this facility. Eggs and early larvae would be the only life stages of sturgeon small enough to be vulnerable to entrainment at the Indian Point intakes (openings in the wedge wire screens are 6mm x 12.5 mm (0.25 inches by 0.5 inches); eggs are small enough to pass through these openings but are not expected to occur in the immediate vicinity of the Indian Point site.

Studies to evaluate the effects of entrainment at IP2 and IP3 occurred from the early 1970s through 1987, with intense daily sampling during the spring of 1981-1987. As reported by the NRC in its FSEIS considering the proposed relicensing of IP2 and IP3 (NRC 2011), entrainment monitoring reports list no shortnose or Atlantic sturgeon eggs or larvae at IP2 or IP3. Given what is known about these life stages (i.e., no eggs expected to be present in the action area; larvae only expected to be found in the deep channel area away from the intakes) and the intensity of the past monitoring, it is reasonable to assume that this past monitoring provides an accurate assessment of past entrainment of sturgeon early life stages. Based on this, it is unlikely that any entrainment of sturgeon eggs and larvae occurred historically.

We have no information on any monitoring for impingement that may have occurred at the IP1 intakes. Therefore, we are unable to determine whether any monitoring did occur at the IP1 intakes and whether shortnose or Atlantic sturgeon were recorded as impinged at IP1 intakes. Despite this lack of data, given that the IP1 intake is located between the IP2 and IP3 intakes and operates in a similar manner, it is reasonable to assume that some number of shortnose and Atlantic sturgeon were impinged at the IP1 intakes during the time that IP1 was operational. However, based on the information available to us, we are unable to make a quantitative assessment of the likely number of shortnose and Atlantic sturgeon impinged at IP1 during the period in which it was operational.

The impingement of shortnose and Atlantic sturgeon at IP2 and IP3 has been documented (NRC 2011). Impingement monitoring occurred from 1974-1990, and during this time period, 21 shortnose sturgeon were observed impinged at IP2. For Unit 3, 11 impinged shortnose sturgeon were recorded. At Unit 2, 251 Atlantic sturgeon were observed as impinged during this time period, with an annual range of 0-118 individuals (peak number in 1975); at Unit 3, 266 Atlantic sturgeon were observed as impinged, with an annual range of 0-153 individuals (peak in 1976). No monitoring of the intakes for impingement has occurred since 1990.

While models of the current thermal plume are available, it is not clear whether this model accurately represents past conditions associated with the thermal plume. As no information on past thermal conditions are available and no monitoring was done historically to determine if the thermal plume was affecting shortnose or Atlantic sturgeon or their prey, it is not possible to estimate past effects associated with the discharge of heated effluent from the Indian Point facility. No information is available on any past impacts to shortnose sturgeon prey due to impingement or entrainment or exposure to the thermal plume. This is because no monitoring of sturgeon prey in the action area has occurred.

6.0 CLIMATE CHANGE

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change in the action area and how listed sturgeon may be affected by those predicted environmental changes over the life of the proposed action. Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Effects of the proposed action that are relevant to climate change are included in the Effects of the Action section below (section 7.0 below).

6.1 Background Information on predicted climate change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a). Precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b); these trends have been most apparent over the past few decades.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3^{o}-5^{o}C (5^{o}-9^{o}F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2^{o}C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene *et al.* 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene *et al.* 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene *et al.* 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Hudson River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Additional information on potential effects of climate change specific to the action area is discussed below. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2^{o}C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

6.2 Species Specific Information Related to Predicted Impacts of Climate Change

6.2.1 Shortnose sturgeon

Global climate change may affect shortnose sturgeon in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers. Shortnose sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile shortnose sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, shortnose sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, for most spawning rivers there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the saltwedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Shortnose sturgeon are tolerant to water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all shortnose sturgeon life stages, including adults, may become susceptible to strandings. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species.

6.2.2 Atlantic sturgeon

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to effect the South Atlantic and Carolina DPSs. Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile Atlantic sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, Atlantic sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the saltwedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Atlantic sturgeon prefer water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all Atlantic sturgeon life stages, including adults, may become susceptible to strandings or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat.

6.3 Potential Effects of Climate Change in the Action Area

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Hudson River largely focuses on effects that rising water levels may have on the human environment. The New York State Sea Level Rise Task Force (Spector in Bhutta 2010) predicts a state-wide sea level rise of 7-52 inches by the end of this century, with the conservative range being about 2 feet. This compares to an average sea level rise of about 1 foot in the Hudson Valley in the past 100 years. Sea level rise is expected to result in the northward movement of the salt wedge. The location of the salt wedge in the Hudson River is highly variable depending on season, river flow, and precipitation so it is unclear what effect this northward shift could have. Potential negative effects of a shift in the salt wedge include restricting the habitat available for early life stages and juvenile sturgeon which are intolerant to salinity and are present exclusively upstream of the salt wedge. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shift that may occur.

Air temperatures in the Hudson Valley have risen approximately 0.5°C (0.9°F) since 1970. In the 2000s, the mean Hudson river water temperature, as measured at the Poughkeepsie Water Treatment Facility, was approximately 2°C (3.6°F) higher than averages recorded in the 1960s (Pisces 2008). However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Hudson River generally. The Pisces report (2008) also states that temperatures within the Hudson River may be becoming more extreme. For example, in 2005, water temperature on certain dates was close to the maximum ever recorded and also on other dates reached the lowest temperatures recorded over a 53-year period. Other conditions that may be related to climate change that have been reported in the Hudson Valley are warmer winter temperatures, earlier melt-out and more severe flooding. An average increase in precipitation of about 5% is expected; however, information on the effects of an increase in precipitation on conditions in the action area is not available.

Sea surface temperatures have fluctuated around a mean for much of the past century, as measured by continuous 100+ year records at Woods Hole (Mass.), and Boothbay Harbor (Maine) and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing; for example, Boothbay Harbor's temperature has increased by about 1°C since 1970. While we are not able to find predictive models for New York, given the geographic proximity of these waters to the Northeast, we assume that predictions would be similar. For marine waters, the model projections are for an increase of somewhere between 3-4°C by 2100 and a pH drop of 0.3-0.4 units by 2100 (Frumhoff *et al.* 2007). Assuming that these predictions also apply to the action area, one could anticipate similar conditions in the action area over that same time period; considering that the proposed action will occur until 2035, we could predict an increase in ambient water temperatures of 0.034-0.045 per year for an overall increase of 0.078-1.035°C .

6.4 Effects of Climate Change in the Action Area to Atlantic and shortnose sturgeon

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose and Atlantic sturgeon. IP2 could operate until 2033 and IP3 could operate until 2035; thus, we consider here, likely effects of climate change over this time period.

Over time, the most likely effect to shortnose and Atlantic sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north which would restrict the range of juvenile sturgeon and may affect the development of these life stages. Upstream shifts in spawning or rearing habitat in the Hudson River are limited by the existence of the Troy Dam (RKM 250, RM 155), which is impassable by sturgeon. Currently, the saltwedge normally shifts seasonally from Yonkers to as far north as Poughkeepsie (RKM 120, RM 75). Given that sturgeon currently have over 75 miles of habitat upstream of the salt wedge before the Troy Dam, it is unlikely that the saltwedge would shift far enough upstream to result in a significant restriction of spawning or nursery habitat. The available habitat for juvenile sturgeon could decrease over time; however, even if the saltwedge shifted several miles upstream, it seems unlikely that the decrease in available habitat would have a significant effect on juvenile sturgeon because there would still be many miles of available low salinity habitat between the salt wedge and the Troy Dam.

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations through the area as sturgeon move to spawning and overwintering grounds. There could be shifts in the timing of spawning; presumably, if water temperatures warm earlier in the spring, and water temperature is a primary spawning cue, spawning migrations and spawning events could occur earlier in the year. However, because spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of sturgeon through the action area.

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon. If sturgeon distribution shifted along with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food. Similarly, if sturgeon shifted to areas where different forage was available and sturgeon were able to obtain sufficient nutrition from that new source of forage, any effect would be minimal. The greatest potential for effect to forage resources would be if sturgeon shifted to an area or time where insufficient forage was available; however, the likelihood of this happening seems low because sturgeon feed on a wide variety of species and in a wide variety of habitats.

Limited information on the thermal tolerances of Atlantic and shortnose sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall *et al.* 2010); in the wild, shortnose sturgeon are typically found in waters less than 28°C. In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.* 2008 and Jenkins *et al.* 1993), however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, have been documented in the lab to experience mortality at temperatures of 33.7°C (92.66°F) or greater and are thought to experience stress at temperatures above 28°C. For purposes of considering thermal tolerances, we consider Atlantic sturgeon to be a reasonable surrogate for shortnose sturgeon given similar geographic distribution and known biological similarities.

Normal surface water temperatures in the Hudson River can be as high as 24-27°C at some times and in some areas during the summer months; temperatures in deeper waters and near the bottom are cooler. A predicted increase in water temperature of 3-4°C within 100 years is expected to result in temperatures approaching the preferred temperature of shortnose and Atlantic sturgeon (28°C) on more days and/or in larger areas. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters.

As described above, over the long term, global climate change may affect shortnose and Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which shortnose or Atlantic sturgeon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect shortnose and Atlantic sturgeon in the action area. While we can make some predictions on the likely effects of climate change on these species, without modeling and additional scientific data these predictions remain speculative. Additionally, these predictions do not take into account the adaptive capacity of these species which may allow them to deal with change better than predicted.

7.0 EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and occur later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects of the proposed action on listed species and their habitat in the action area within the context of the species current status, the environmental baseline and cumulative effects. The effects of the proposed action are the effects of the continued operation of IP2 and IP3 pursuant to the existing and proposed renewed licenses proposed to be issued by the NRC pursuant to the Atomic Energy Act. NRC has requested consultation on the proposed extended operation of the facilities under the same terms as in the existing licenses and existing SPDES permits.

The proposed action has the potential to affect shortnose and Atlantic sturgeon in several ways: impingement or entrainment of individual sturgeon at the intakes; altering the abundance or availability of potential prey items; and, altering the riverine environment through the discharge of heated effluent and other pollutants.

7.1 Effects of Water Withdrawal

Under the terms of the existing licenses and the proposed renewal licenses, IP2 and IP3 will continue to withdraw water from the Hudson River for cooling. Both units utilize once through cooling and will continue to use once through cooling during the extended operating period, assuming no changes are made to the proposed action. Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. According to the draft SPDES permit for the facility, the NYDEC has determined for CWA purposes that the site-specific best technology available to minimize the adverse environmental impacts of the IP cooling water intake structures is closed-cycle cooling (NYDEC 2003b). IP2 and IP3 currently operate pursuant to the terms of the SPDES permits issued by NYDEC in 1987 but administratively extended since then. NYDEC issued a draft SPDES permit in 2003. Its final contents and timeframe for issuance are uncertain, given it is still under adjudication at this time. While it is also uncertain that the facility will be able to operate under the same terms as those in its existing license and SPDES permit, NRC sought consultation on its proposal to renew the license for the facility under the same terms as the existing license and SPDES permit, which authorize once through cooling. Here, we consider the impacts to shortnose and Atlantic sturgeon of the continued operation of IP2 and IP3 with the existing once through cooling system and existing SPDES permits from now through the duration of the proposed license renewal period for IP2 and IP3 (i.e., through September 2033 and December 2035, respectively). But, it is important to note that changes to the effects of the action, including but not limited to changes in the effects of the cooling water system, as well as changes in other factors, may trigger reinitiation of consultation (see 50 CFR 402.16).

7.1.1 Entrainment

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects small organisms with limited swimming ability that can pass through the screen mesh, used on the intake systems. Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000 in NRC 2011). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

7.1.1.1 Entrainment of Shortnose Sturgeon

The southern extent of the shortnose sturgeon spawning area in the Hudson River is approximately RM 118 (rkm 190*),* approximately 75 miles (121 km) upstream of the Indian Point facility. The eggs of shortnose sturgeon are demersal, sinking and adhering to the bottom of the river, and, upon hatching the larvae in both yolk-sac and post-yolk-sac stages remain on the bottom of the river, primarily upstream of RM 110 (rkm 177) (NMFS 2000). Because eggs do not occur near the IP intakes, there is no probability of entrainment. Shortnose sturgeon larvae are 20mm (0.8 inches) in length at the time they begin downstream migrations (Buckley and Kynard 1995). Because of intolerance to salinity, larvae occur only in freshwater, above the salt wedge. The location of the salt wedge in the Hudson River varies both seasonally and annually, depending at least partially on freshwater input (e.g., rainfall, snow melt). In many years, the salt wedge is located upstream of the Indian Point intakes; in those years, larvae would not be expected to occur near the IP intakes as the salinity levels would be too high. However, at times when the salt wedge is downstream of the intakes, which is most likely to occur in the late summer, there is the potential for shortnose sturgeon larvae to be present in the action area. Larvae occur in the deepest water and in the Hudson River, they are found in the deep channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae grow rapidly and after a few weeks are too large to be entrained by the cooling water intake; thus, any potential for entrainment is limited to any period when individuals are small enough to pass through the openings in the mesh screens that coincide with a period when the salt wedge is located downstream of the intakes. Given the distance between the intake and the deep channel (2000 feet; 610 meters) where any larvae would be present if in the action area, larvae are unlikely to occur near the intake where they could be susceptible to entrainment.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system. IP2 and IP3 monitored entrainment from 1972 through 1987. Entrainment monitoring became more intensive at Indian Point from 1981 through 1987, and sampling was conducted for nearly 24 hours per day, four to seven days per week, during the spawning season in the spring. As reported by NRC, entrainment-monitoring reports list no shortnose sturgeon eggs or larvae at IP2 or IP3. During the development of the HCP for steam electric generators on the Hudson River, NMFS reviewed all available entrainment data. In the HCP, NMFS (2000) lists only eight sturgeon larvae collected at any of the mid-Hudson River power plants (all eight were collected at Danskammer (approximately 23 miles upstream of Indian Point), and four of the eight may have been Atlantic sturgeon). Entrainment sampling data supplied by the applicant (Entergy 2007b) include large numbers of larvae for which the species could not be determined; however, NRC has indicated that as sturgeon larvae are distinctive it is unlikely that sturgeon larvae would occur in the "unaccounted" category as it is expected that if there were any sturgeon larvae in these samples they would have been identifiable. Entergy currently is not required to conduct any monitoring program to record entrainment at IP2 and IP3; however, it is reasonable to use past entrainment results to predict future effects. This is because: (1) there have not been any operational changes that make entrainment more likely now than it was during the time when sampling took place and, (2)there have been no changes in the locations where sturgeon spawn which would increase the exposure of eggs or larvae to entrainment. Additionally, the years when intense entrainment sampling took place overlap with two of the years (1986 and 1987; Woodland and Secor 2007) when shortnose sturgeon recruitment is thought to have been the highest and therefore, the years when the greatest numbers of shortnose sturgeon larvae were available for entrainment. Reliance on the lack of observed entrainment of shortnose sturgeon during sampling at IP2 and IP3 is also reasonable given the known information on the location of shortnose sturgeon spawning and the distribution of eggs and larvae in the river.

NRC was not able to provide NMFS with any historical monitoring data from the IP1 intakes and it is not clear if any monitoring at IP1 ever occurred. However, given that the IP1 intake (used for service water for IP2) is located adjacent to the IP2 and IP3 intakes and that intake velocity and screen size is comparable to IP2 and IP3 it is reasonable to expect that the potential for entrainment of early life stages of shortnose sturgeon at the IP1 intake is comparable to the potential for entrainment of early life stages of shortnose sturgeon at the IP2 and IP3 intakes.

Based on the life history of the shortnose sturgeon, the location of spawning grounds within the Hudson River, and the patterns of movement for eggs and larvae, it is extremely unlikely that any shortnose sturgeon early life stages would be entrained at IP2 and/or IP3. This conclusion is supported by the lack of any eggs or larvae positively identified as sturgeon and documented during entrainment monitoring at IP2 or IP3. Provided that assumption is true, NMFS does not anticipate any entrainment of shortnose sturgeon eggs or larvae in the future when IP2 and IP3 are operating pursuant to their current licenses or when they are operating pursuant to their extended operating license (i.e., through September 2033 and December 2035, respectively). It is important to note that this determination is dependent on the validity of the assumption that none of the unidentified larvae were shortnose sturgeon. All other life stages of shortnose sturgeon are too big to pass through the screen mesh and could not be entrained at the facility. As NMFS expects that the potential for entrainment of shortnose sturgeon at the IP1 intake is comparable to IP2 and IP3, NMFS does not anticipate any entrainment of any life stage of shortnose sturgeon at the IP1 intake, as used for service water for IP2.

7.1.1.2 Entrainment of Atlantic sturgeon

In order to be entrained, Atlantic sturgeon would need to be small enough to pass through the mesh of the traveling screens (0.25-by-0.5-inch (in.) (0.635-by-1.27 centimeters (cm)). Eggs are adhesive and demersal and occur only on the spawning grounds. At hatching, Atlantic sturgeon larvae are approximately 7.8 mm TL (Smith 1980, 1981)). As described above, the location of spawning in a given year is likely dependent on the location of the salt wedge; the most recent reports of spawning have been upstream of river kilometer 112 (Van Eenennaam *et al.*, 1996; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Young-of-year (YOY) have been recorded in the Hudson River between rkm 60 and rkm 148; which, because young of year are not likely to make extensive upstream movements, indicates that spawning likely occurs upstream of these areas. Larvae must remain upstream of the salt wedge because of their low salinity tolerance (Dovel and Berggren, 1983; Kahnle *et al.*, 1998; Bain *et al.*, 2000).

As noted above, the location of the salt wedge in the Hudson River varies both seasonally and annually, depending at least partially on freshwater input. In many years, the salt wedge is located upstream of the Indian Point intakes; in those years, larvae would not be expected to occur near the IP intakes as the salinity levels would be too high. However, at times when the salt wedge is downstream of the intakes, which is most likely to occur in the late summer, there is the potential for Atlantic sturgeon larvae to be present in the action area. Like shortnose sturgeon, Atlantic sturgeon larvae occur in the deepest water and in the Hudson River, they are found in the deep channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae grow rapidly; at hatching larvae are within 2 mm of the size of the opening of the mesh, in a short time they are too large to be entrained by the cooling water intake. Any potential for entrainment is limited to any period when individuals are small enough to pass through the openings in the mesh screens that coincide with a period when the salt wedge is located downstream of the intakes. Given the distance between the intake and the deep channel (2,000 feet; 610 meters) where any larvae would be present if in the action area, larvae are unlikely to occur near the intake where they could be susceptible to entrainment. No Atlantic sturgeon larvae have been documented as entrained at IP2 or IP3. The nearest documentation of Atlantic sturgeon larvae to IP2 and IP3 is at the Danskammer facility, approximately 23 miles upstream.

Based on the life history of Atlantic sturgeon, the location of spawning grounds within the Hudson River, and the patterns of movement for eggs and larvae, it is extremely unlikely that any Atlantic sturgeon early life stages would be entrained at IP2 and/or IP3. This conclusion is supported by the lack of any eggs or larvae positively identified as sturgeon and documented during entrainment monitoring at IP2 or IP3. Provided that assumption is true, we do not anticipate any entrainment of shortnose sturgeon eggs or larvae in the future when IP2 and IP3 are operating pursuant to their current licenses or when they are operating pursuant to their extended operating license (i.e., through September 2033 and December 2035, respectively). It is important to note that this determination is dependent on the validity of the assumption that none of the unidentified larvae were Atlantic sturgeon. All other life stages of Atlantic sturgeon are too big to pass through the screen mesh and could not be entrained at the facility. As we expect the potential for entrainment of Atlantic sturgeon at the IP1 intake is comparable to IP2 and IP3, we do not anticipate any entrainment of any life stage of Atlantic sturgeon at the IP1 intake, as used for service water for IP2.

7.1.2 Impingement

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement can kill organisms immediately or contribute to death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwashing and fish return system that the plant operator uses. Below, NMFS considers the available data on the impingement of shortnose and Atlantic sturgeon at the facility and then considers the likely rates of mortality associated with this impingement.

Impingement only occurs when a fish cannot swim fast enough to escape the intake (e.g., the fish's swimming ability is overtaken by the velocity of water being sucked into the intake). A few studies have been carried out to examine the swimming ability of sturgeon and their vulnerability to impingement. Generally speaking, fish swimming ability, and therefore ability to avoid impingement and entrainment, are affected not just by the flow velocity into the intakes, but also fish size and age, water temperature, level of fatigue, ability to remain a head-first orientation into current, and whether the fish is sick or injured.

Kynard et al. (2005) conducted tests in an experimental flume of behavior, impingement, and entrainment of yearlings (minimum size tested 280mm FL, 324mm TL), juveniles (minimum size tested 516mm FL, 581mm TL) and adult shortnose sturgeon (minimum size tested 600mmFL, 700mm TL). Impingement and entrainment were tested in relation to a vertical bar rack with 2 inch clear spacing. The authors observed that after yearlings contacted the bar rack, they could control swimming at 1 and 2 feet/sec, but many could not control swimming at 3 feet/sec velocity. After juveniles or adults contacted the rack, they were able to control swimming and move along the rack at all three velocities. During these tests, no adults or juveniles were impinged or entrained at any approach velocity. No yearlings were impinged at velocities of 1 ft/sec, but 7.7-12.5% were impinged at 2 ft/sec, and 33.3-40.0% were impinged at 3 ft/sec. The range of entrainment of yearlings (measured as passage through the rack) during trials at 1, 2, and 3 ft/sec approach velocities follow: 4.3-9.1% at 1 ft/sec, 7.1-27.8% at 2 ft/sec, and 66.7-80.0% at 3 ft/sec. From this study, we can conclude that shortnose sturgeon that are yearlings and older (at least 280mm FL) would have sufficient swimming ability to avoid impingement at an intake with velocities of 1 fps or less.

The swimming speed that causes juvenile shortnose sturgeon to experience fatigue was investigated by Deslauriers and Kieffer (2012). Juvenile shortnose sturgeon (19.5 cm average total length) were exposed to increasing current velocities in a flume to determine the velocity that caused fatigue. Fish were acclimated for 30 minutes to a current velocity of 5 cm/sec (0.16 fps). Current velocities in the flume then were increased by 5 cm/sec increments for 30 minutes per increment until fish exhibited fatigue. Fish were considered fatigued when they were impinged on the down-stream plastic screen for a period of 5 seconds (Deslauriers and Kieffer (2012).

The current velocity that induced fatigue was reported as the critical swimming speed ("U_{crit}") under the assumption that the fish swam at the same speed as the current. The effect of water temperature on U_{crit} for juvenile shortnose sturgeon was determined by repeating the experiment at five water temperatures: 5°C, 10°C, 15°C, 20°C and 25°C. Shortnose sturgeon in this study swam at a maximum of 2.7 body lengths/second (BL/s) at velocities of 45 cm/s (1.47 fps). In this study, the authors developed a prediction equation to describe the relationship between Ucrit and water temperature. The authors report that amongst North American sturgeon species, only the pallid and shovelnose sturgeon have higher documented U_{crit} values (in BL/s) than shortnose sturgeon at any given temperature .

Boysen and Hoover (2009) conducted swimming performance trials in a laboratory swim tunnel with hatchery-reared juvenile white sturgeon to evaluate entrainment risk in cutterhead dredges. The authors observed that 80% of individuals tested, regardless of size (80-100mm TL) were strongly rheotactic (i.e., they were oriented into the current), but that endurance was highly variable. Small juveniles (< 82 mm TL) had lower escape speeds (< 40 cm/s (1.31fps)) than medium (82–92 mm TL) and large (> 93 mm TL) fish (42–45 cm/s (1.47 fps)). The authors concluded that the probability of entrainment of juvenile white sturgeon could be minimized by maintaining dredge head flow fields at less than 45 cm/s (1.47 fps).

Hoover et al. (2011) used a Blazka-type swim tunnel, to quantify positive rheotaxis (head-first orientation into flowing water), endurance (time to fatigue), and behavior (method of movement) of juvenile sturgeon in water velocities ranging from 10 to 90 cm/s (0.3-3.0 fps). The authors tested lake and pallid sturgeon from two different populations in the U.S. Rheotaxis, endurance, and behavioral data were used to calculate an index of entrainment risk, ranging from 0 (unlikely) to 1.00 (inevitable), which was applied to hydraulic models of dredge flow fields. The authors concluded that at distances from the draghead where velocity had decreased to 40cm/s (1.31 fps) entrainment was unlikely.

7.1.2.1 Impingement of Shortnose Sturgeon at Indian Point

Impingement of most fish species at IP2 and IP3 was monitored daily until 1981. Impingement of sturgeon species was monitored daily from 1974-1990 (Entergy 2009). Collections were reduced to a randomly selected schedule of 110 days per year until 1991, and then monitoring ceased in 1991 with the installation of the modified Ristroph traveling screens.

After NRC submitted its 2008 BA, Entergy submitted revised impingement data to NRC to correct certain accounting errors related to sampling frequency. The corrected impingement data for shortnose sturgeon, presented in NRC's 2010 BA, is summarized below (Table 2). The actual observed number of impingements is recorded as "Observed Fish" below (called the Level 5 Count in NRC 2010 and 2012). This number was adjusted to account for collection efficiency to determine the "Estimated Fish" below (the "CE Adjusted Level 5 Count" in NRC 2010 and 2012).

A total of 32 shortnose sturgeon were observed during impingement monitoring at IP2 and IP3 from 1974-1990. Adjusting for collection efficiency, it is estimated that a total of 71 shortnose sturgeon were impinged at IP2 and IP3 during this period. For this period, the average number of shortnose sturgeon impinged per year at IP2 and IP3 was 4.2 shortnose sturgeon/year (see Table 2 below).

Table 2. Actual and Adjusted Level of Annual Impingement of Shortnose Sturgeon 1974-1990

	IP2		***IP3***		
Year	**Observed Fish**	**Estimated Fish**	**Observed Fish**	**Estimated Fish**	**Total IP2 and IP3 Annual Estimate**
1974	3	9	0	0	9
1975	1	3	NR	NR	3*
1976	1	2	0	0	2
1977	5	11	1	2	13
1978	2	5	3	5	10
1979	2	4	2	3	7
1980	0	0	1	2	2
1981	0	0	0	0	0
1982	0	0	0	0	0
1983	0	0	0	0	0
1984	1	3	1	2	5
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	2	4	1	2	6
1988	3	7	1	2	9
1989	0	0	1	2	2
1990	1	3	0	0	3
Total	21	**51**	11	**20**	**71**

In addition to the withdrawal of water from the IP2 and IP3 intakes for cooling water and service water, additional service water for IP2 is withdrawn through the IP1 intakes. This intake is located between the IP2 and IP3 intakes, also along the eastern shore of the Hudson River. NRC was not able to provide NMFS with any monitoring data from IP1 and it is unclear if any monitoring at IP1 has ever occurred. As such, we have no reports of impingement at IP1 and none of the materials submitted by NRC or Entergy have contained an estimate of impingement at IP1.

Following the reinitiation of consultation in 2012, Entergy provided us with a report on shortnose and Atlantic sturgeon impingement at Indian Point (Entergy 2012). According to the report, Entergy has made the assumption that the likelihood of impingement is related to the amount of water withdrawn. This seems to be a reasonable assumption as the more water that is withdrawn through the intakes the greater the opportunity is for impingement. Entergy reports that the amount of water withdrawn varies seasonally and annually. They suspect that these differences could account for some of the interannual variability in impingement of sturgeon. To account for interannual variations in operations, Entergy calculated an “impingement density” of sturgeon; that is, the number of sturgeon/volume of water withdrawn (cooling plus service water). This value was calculated using the adjusted impingement values (Estimated Fish in the table above) from 1976-1990 and the actual water withdrawal rates from IP2 and IP3 during the same period. Monthly average impingement densities were estimated by dividing the total number of sturgeon impinged during that month by the actual average withdrawal rate (gpm x 106) for the month (Entergy 2012). Using this method, Entergy determined that on average during 1976-1990, the highest impingement occurred in April (approximately 1 per month), with the lowest impingement (none) occurring in the June, July or December. In other months, the average was less than one per month.

Impingement density values are shown for each year 1976 through 1990[11] for shortnose sturgeon in Figure 2. This figure presents year on the horizontal axis and the vertical axis shows the annual sturgeon impingement density (sturgeon per million gpm) for IP2 and IP3 combined. The annual sturgeon impingement density shown on the vertical axis of Figure 2 is calculated as the annual number (count) of sturgeon impinged and then scaled upward by monthly collection efficiency values for each Unit in each year and divided by the annual average cooling water withdrawal rate for that Unit and year in million gallons per minute. The impingement density values plotted on the vertical axis in Figure 3 represents the sum of each density value for IP2 and IP3 for each year.

Annual shortnose sturgeon impingement density (average of monthly estimates of impingement density based on number impinged and the average monthly flow rate) ranged from 0 (1981, 1982, 1983, 1985 and 1986) to 2.1 (1977). These are also the years with the lowest and highest estimated total impingement (see Table above).

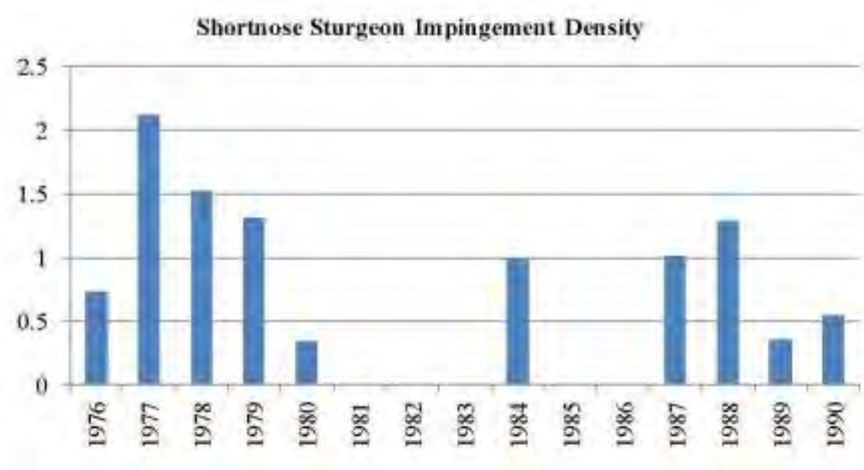


Figure 2. Among year pattern of shortnose sturgeon impingement density at IP2 and IP3 (combined). Annual density is the average of monthly estimates of impingement density based on number impinged and the average monthly flow rate (million gpm). From Entergy 2012.

[11] Entergy used the years 1976-1990 for this method because those were the years that flow data was available. Also, IP3 was not operational in 1975.

Figure 3. Among-month pattern of average shortnose sturgeon impingement at IP2 and IP3, and average IP flows (cooling water plus service water) for the years 1976-1990.

These calculations suggest that there may be factors other than water withdrawal volume that contributed to the number of sturgeon impinged at IP2 and IP3. For example, according to the information presented in Figure 3, June and July (months 6 and 7) are two of the months with the highest amount of water withdrawal, yet there is an average of zero impingements during these months. We would also expect that if the volume of water withdrawn was the only factor associated with impingement, there would be very little variability in impingement density from one year to the next. As demonstrated in Figure 2 there is substantial variability in impingement density from year to year.

Possible explanations for monthly and annual differences in impingement density include environmental conditions (i.e., water temperature, availability of forage, location of the salt wedge) that would influence the likelihood of shortnose sturgeon presence in the action area as well as changes in the number of sturgeon in the action area due to the strength of various year classes and overall size of the population. We do not have data on water temperature, availability of forage or location of the salt wedge for the time period that impingement monitoring occurred; therefore we are not able to explore any of these possible explanations. As discussed in more detail below, shortnose sturgeon in the Hudson River experienced an increasing trend over the time period that impingement monitoring occurred. We would expect that there would also be an increasing trend in impingement due to the presence of a greater number of shortnose sturgeon in the Hudson River, particularly after 1985; however, this is not seen.

Predicted Future Impingement of Shortnose Sturgeon
Shortnose sturgeon can be impinged at the IP1, IP2 or IP3 intakes. In front of all three intakes there are trash bars with 3-inch spacing between them. According to information provided by Entergy, approach velocities outside of the trash bars at IP2 and IP3 are approximately 1.0fps at full flow and 0.6fps at reduced flow (Enercon 2010; Entergy 2007). Fish that are narrower than 3-inches may pass through the trash bars. Fish wider than 3-inches could be vulnerable to impingement on the trash racks if they were not able to swim away. Once inside the trash racks, fish that do not swim back out through the racks into the river can be impinged at the screens in front of the intakes. At IP2 and IP3 there are modified Ristroph traveling screens. Fletcher (1990) reports that the mean water velocity in the area between the trash rack and the traveling screens was 30cm/second (0.98 feet/second) and varied with the tide during testing of the screens carried out in 1986. Fletcher (1990) does not report the range of velocities that are experienced in this area. The traveling screens continually move vertically through the water column as they rotate. The Ristroph screens have a screen basket equipped with a water-filled lifting bucket. Fish can be forcibly impinged on the screens or can be captured by the buckets. As each bucket passes over the top of the screen, fish are rinsed into a collection trough by a spraywash system.

Comment [A4]: Question to NRC – how far outside the trash bars is this velocity reported? The reports state "approximately" – what is the range of velocities that are experienced. What is the "through-rack" velocity? What is the range of water velocity between the trash rack and the Ristroph screens (Fletcher 1990 reports an average of 30cm/s)?

If through-rack velocity at the trash racks in front of IP1, IP2 and IP3 is 1.0 fps, as reported by Entergy, we would not anticipate any impingement of shortnose sturgeon at the trash racks. That is because sturgeon that are big enough to not be able to pass through the racks (i.e., those that have body widths greater than three inches) would be adults. These fish are able to avoid impingement at velocities of up to 3 feet per second and should be able to readily avoid getting stuck on the trash racks.

Entergy and Fletcher (1990) both report that velocities in front of the traveling screens are on average 1.0 fps or less. The laboratory studies on sturgeon swimming ability discussed in Section 7.1.2 indicate that shortnose sturgeon older than one year and larger than 28cm long should be able to avoid impingement. The Kynard study suggest that impingement rates for yearlings would be less than 10% at this intake velocity.

We examined the available data on shortnose sturgeon impinged at IP2 and IP3 to determine the length of impinged fish. Of the 32 shortnose sturgeon recorded at IP2 and IP3 from 1974-1990, length is available for only nine individuals. These fish ranged in size from 32-71 cm. This is consistent with our estimates of the size of fish that would be able to pass through the trash bars but is larger than the size of fish we would expect to be vulnerable to impingement if the flow velocity is 1 fps.

Entergy applied the prediction equation for U_{crit} as a function of water temperature (from Deslauriers and Kieffer 2012) to the range of monthly water temperatures in the vicinity of IP2 and IP3 to estimate the minimum size of sturgeon that would have a U_{crit} swimming speed greater than the through-screen velocity and therefore should be able to avoid impingement at IP2 and IP3 (Entergy 2012). In the equation, the through-screen intake velocity was assumed to be 1.0 ft/sec for full flow conditions and 0.6 ft/sec for reduced flow conditions (Enercon 2010).

Comment [A5]: Question to NRC: What are these assumptions based on? What is the data that resulted in flow estimates of 1 ft/sec for full flow and 0.6 for reduced flow. To get those figures, was there a field study across a range of conditions or are these calculations based on pump specifications or something else?

Based on the average historical flows at IP2 and IP3 (Figures 2 and 3), Entergy assumed that full flow conditions might exist from May through October, and reduced flow conditions would exist from November through April.

The results of Entergy's analysis indicate that healthy sturgeons over 19.5 cm TL should be capable of sustained avoidance of impingement at IP2 and IP3 throughout the year. Entergy states that these results may be conservative. In an earlier study, Kieffer et al. (2009) measured U_{crit} values for juvenile shortnose sturgeon ranging in length from 14 to 18 cm TL at a temperature of 15°C. These authors estimated U_{crit} at this temperature to be 2.18 BL/sec. Assuming this value, any shortnose sturgeon longer than 14.0 cm TL would be able to avoid impingement during the months of May through September, when the average water temperature at Indian Point is equal to or greater than 15°C.

Based on the size of the shortnose sturgeon that have been impinged at IP2 and IP3 and the analysis completed by Entergy, it appears that there are other factors than the size of the fish that are contributing to the likelihood of impingement. It is possible that the configuration of the buckets on the traveling screen results in the capture of sturgeon prior to them getting "stuck" on the screens. This would explain why fish of a size that should be able to avoid impingement on the traveling screens have been documented during impingement sampling. It is interesting to note that Fletcher (1990) reports that striped bass are capable of sustained swimming at the flow speeds (mean 30cm/s) in front of the Ristroph screens yet during sampling at one intake bay in September and October 1986, 86 striped bass were documented as impinged (as determined by observation of individuals in the fish return sluice or the debris return sluice). Fletcher (1990) reports that the vast majority of these striped bass were not dead or dying upon collection. Of the 86 individuals, 2 were "damaged" and 5 were dead when collected. Fletcher suggests that freely swimming fish (which we would expect sturgeon to be) will still encounter the collection troughs with the likelihood of encounter increasing with the length of time that the fish spends in the collection area.

Another possible explanation for the impingement of shortnose sturgeon that are of sufficient size to avoid impingement at the reported intake velocities is that these fish are impaired prior to impingement. Fish that are sick or injured may have reduced swimming speed or endurance and may not be able to avoid impingement the way a healthy fish would. Unfortunately, the data that are available on the 32 impinged shortnose sturgeon only indicate condition (alive or dead) for nine individuals. We examined the available information to see if there was a relationship between the length of these nine fish and whether they were alive or dead, and there did not appear to be a relationship between size and condition.

It is also possible that fish that pass through the trash bars become tired or disoriented when trying to find an escape route. Even if through-rack velocity is not high enough to preclude fish from exiting the area, they may have difficulty finding a way out, especially if there is debris in front of the trash bars. Information presented by Fletcher (1990) on the length of time that fish spent in the area between the trash racks and the Ristroph screens supports this idea; for marked striped bass during a release-recapture study at Indian Point, the mean time spent in the area

between the trash racks and Ristroph screens prior to observation in the fish return sluice was 9.73 hours.
We have considered whether the thermal plume may affect shortnose sturgeon in a way that increases the potential for impingement (see 7.2.1, below) and have determined that based on the available information on the thermal plume, it is not likely that the thermal plume directly influences impingement of sturgeon. The impingement of sturgeon at IP2 and IP3 is probably due to a combination of the factors mentioned above, all of which explain how impingement can occur despite intake velocities at levels that are below those that most sturgeon should be able to readily escape from. The lack of information on the condition of the impinged shortnose sturgeon makes it difficult to draw any conclusions about other factors that may contribute to impingement, including the impact of the thermal plume on the swimming endurance of sturgeon near the intake. Despite the low intake velocity reported by Entergy, impingement of sturgeon occurred in the past and likely continues to occur. The lack of recent monitoring data makes predictions of future impingement more difficult. Estimating future impingement is made more difficult by the variability in annual impingement rates and not knowing the degree to which factors discussed above contribute to these differences. We have considered several ways to estimate likely future impingement including: (1) using the annual average number of impingements to predict future impingement; and (2) using Entergy's impingement density calculations.

Calculations based on Impingement data from 1974-1990
During the period that impingement sampling occurred, the number of shortnose sturgeon impinged ranged from zero to 13. The average annual impingement was 4.2 shortnose sturgeon/year. Excluding 1975, when only IP2 was operational, the average was 4 per year. As noted in the Status of the Species section of this Opinion, the shortnose sturgeon population has grown since the time impingement monitoring ceased. Therefore, we considered if the average impingement rate during 1974-1990 would underestimate future impingement.

We have made the basic assumption that the risk of impingement increases with the size of the population. That is, we expect that if there are more fish in the river there is more opportunity for individuals to be impinged. We expect if there are more sturgeon in the action area then the impingement rate would be higher. The shortnose sturgeon population in the Hudson River exhibited tremendous growth in the 20 year period between the late 1970s and late 1990s, with exceptionally strong year classes between 1986-1992 thought to have led to resulting increases in the subadult and adult populations sampled in the late 1990s (Woodland and Secor 2007). According to data presented by Bain (2000) and Woodland and Secor (2007), there were 4 times as many shortnose sturgeon in the Hudson River in the late 1990s as compared to the late 1970s. An increasing trend is also observed in the juvenile index of shortnose sturgeon (prepared by NYDEC) and the CPUE of the utilities Long River and Fall Shoals Survey (Mattson 2012). Woodland and Secor (2007) state that the population of shortnose sturgeon is currently stable at the high level described also by Bain (2000).

The period for which impingement sampling occurred (1974-1990) partially overlaps with the period of increased recruitment. During the portion of the sampling period that overlaps with the period of increased recruitment (1986-1990) the increases in the shortnose sturgeon population would have been fish less than 4 years old. Those are the year classes that would be most vulnerable to impingement. As such, we would expect a peak in impingement numbers from 1986-1990; however, such a peak is not seen in the data that is available to us. In fact, average impingement from 1986-1990 is just slightly higher (five fish per year, collectively at IP2 and IP3) as compared to the 17-year average, and is lower than the average from 1976-1980 (7.4 fish/year collectively at IP2 and IP3) and two of the years (1985 and 1986) had no impingement. One possible explanation is that the fish being impinged are not the small fish (yearlings) that we expect (see above), so even if there was an increase in the number of yearling shortnose sturgeon during this period that may not be reflected in the impingement numbers. It is also possible that while there was an increase in the number of yearlings from 1986-1990 as compared to earlier years, the size of the total population was not significantly different. This could be the case as shortnose sturgeon are long-lived fish, and there are expected to be at least 20-30 year classes in the river at one time. Another explanation is that the location of the salt wedge during 1986-1990 or a subset of those years precluded or minimized the use of the action area by juvenile shortnose sturgeon, which could also affect the impingement rate; however, we do not have the information necessary to investigate that hypothesis as salt wedge location data are only available since 1990.

Entergy conducted an analysis to determine if there was a statistically significant correlation between reported shortnose sturgeon population size and impingement density. It is expected that the more sturgeon there were in the river, the higher the impingement density would be because there would be more sturgeon that had the potential to be impinged. However, the analysis does not reveal a statistically significant correlation (Entergy 2012). It is likely that this lack of statistical correlation is not due to the fact that there is no relationship between population size and impingement but because impingement of sturgeon is a rare event which makes detection of a statistically significant correlation difficult.

As noted above, one factor that may affect the likelihood of impingement is the condition of fish prior to impingement, which may dilute the relationship between numbers of fish in the river and impingement rates. Factors that have changed over time that could be related to the condition of fish in the action area are water quality, and bycatch in the direct Atlantic sturgeon fishery and the American shad fishery. The directed fishery for Atlantic sturgeon occurred until 1996. Because impingement monitoring was discontinued after 1990, we are not able to make any comparisons of impingement rates during years when fishing was occurring and years it was not. We also do not have any information on the intensity of fishing effort over time or the bycatch rate of shortnose sturgeon that we could use to compare to the impingement rates at IP2 or IP3. Similarly, we do not have the necessary information on the shad fishery to compare to the impingement rates. We do know that, generally, water quality improved significantly in the Hudson River beginning in the mid-1970s. This improvement is considered by Woodland and Secor to be one of the primary factors contributing to the increase in the shortnose sturgeon population. It is possible that improvements in water quality resulted in an improvement of the general health of sturgeon in the action area which could have contributed to a reduction in impingement despite an increase in the number of shortnose sturgeon in the action area. Similarly, a reduction in fishing effort could lead to a reduction in bycatch and subsequent release of injured or stressed fish. However, all of this is speculative.

Other factors that may explain interannual variability in impingement numbers that are not related to absolute population size are environmental conditions in the river that are associated with the distribution of shortnose sturgeon. As established above, younger, smaller sturgeon are most likely to be vulnerable to impingement. These fish are restricted to the area of the river above the salt-freshwater interface. In some years, the saltwedge is located downstream of the Indian Point intakes and in some years it is above the Indian Point intakes. In years when the saltwedge is located further upstream, impingement would be expected to be low because, regardless of the total number of shortnose sturgeon in the river at that time, there would be few, if any, juveniles in the action area. The salt front (100 milligrams per liter of chloride) ranges from below Hastings-on-Hudson to New Hamburg during most years, but can move as far north as Poughkeepsie during periods of drought. As such, in drier periods, when the salt front is above Buchannan, we would anticipate that very few juvenile sturgeon would be present in the action area. Unfortunately, the available data on the location of the salt front in the Hudson River (October 1991 – March 2012; USGS 2012), do not overlap at all with the period of time for which impingement data is available. Therefore, we are unable to test this hypothesis regarding relationship between salt wedge location and impingement.

We considered reviewing impingement data for other Hudson River power plants to determine if this predicted correlation between increases in population size and increased impingement of individuals would be observed. Long term shortnose sturgeon impingement monitoring is only available for the Roseton and Danskammer facilities. However, since 2000, both facilities have operated at reduced rates and there has been minimal shortnose sturgeon impingement; in every year it has been less than the 2 and 4 impingements estimated respectively for these two facilities. As the Roseton and Danskammer facilities are not currently operating in the same capacity they were in the past, it is not possible to make an accurate comparison of past and present impingement which could serve to determine if it was reasonable to assume that an increase in impingement would occur in association with an increase in the number of shortnose sturgeon in the Hudson River. As noted above, the Lovett facility has been closed. The Bowline facility has always operated with extremely low levels of impingement, thought to be primarily due to the location of the intakes in a nearly enclosed embayment of the River where shortnose sturgeon are thought to be unlikely to occur (Bowline Pond) (NMFS 2000). Therefore, we are not able to use information from other power intakes to determine if there is an association between changes in population size and rates of impingement.

We also considered examining relationships between population trend and impingement rates at facilities outside the Hudson River. Monitoring of sturgeon impingement at the Salem Nuclear Generating Station, on the Delaware River, has been ongoing since 1978. However, the population of shortnose sturgeon in the Delaware River has been stable at approximately 12,000 adults since 1981. The impingement rate has similarly been stable at an average of less than one fish per year throughout this period. Because of the stable trend in the population and the impingement rate at this facility, it is not possible to use this information to determine if changes in population size are related to changes in impingement rates.

Despite the uncertainty in determining the factors that are related to impingement, the assumption that the more sturgeon there are in the river the higher the potential for impingement, is reasonable. If we adjust the average number of shortnose sturgeon impinged annually at IP2 and IP3 by 400% (the increase in the size of the population reported by Bain and Woodland and Secor), we would anticipate the impingement of an average of 16 shortnose sturgeon per year at IP2 and IP3 (combined) during the period that these facilities will continue to operate (i.e., 1974-1990 annual average was 4, times 4 = 16). From September 2033 – December 2035, only IP3 will be operational. During the period 1974-1990, approximately 28% of the impinged shortnose sturgeon were at IP3. Using that ratio and applying it to the estimate of 16 shortnose sturgeon when both facilities are operational, we expect an average of 4.5 shortnose sturgeon to be impinged annually when just IP3 is operational. Over the two year period we expect the impingement of nine shortnose sturgeon.

In addition to the withdrawal of water from the IP2 and IP3 intakes for cooling water and service water, additional service water for IP2 will be withdrawn from the IP1 intakes. This intake is located between the IP2 and IP3 intakes, also along the eastern shore of the Hudson River. NRC was not able to provide us with any monitoring data from IP1, and it is unclear if any monitoring at IP1 has ever occurred. Given the lack of intake specific monitoring data, we have assessed the likelihood of impingement of shortnose sturgeon at the IP1 intakes as compared to the likelihood of impingement at the IP2 and IP3 intakes. As noted above, there is no geographic difference in intake location which would make impingement at IP1 more or less likely at IP2 or IP3. The intake velocity, trash bar spacing and screen mesh size are also comparable between IP1 and IP2 and IP3. The major difference between the IP1 intake and the IP2 and IP3 intakes is the volume of water removed. Together, IP2 and IP3 remove a maximum flow of approximately 1.746 million gallons per minute. According to information provided by Entergy[12], the IP1 intake structure has two redundant forebays, each with a maximum or design flow of 10,000 gpm; however, as currently configured in a redundant manner, the maximum flow of the intake is 10,000 gpm. Entergy further indicates that the typical peak operating flow for IP1 is 5,500 gpm with 6,000 gpm as the limit of the IP2 load.

Given the maximum 6,000 gpm operation of the IP1 intake, this represents approximately 0.34% of the total intake flow from IP2 and IP3 (6,000gpm/1,746,000gpm). Assuming, that all other parameters being equal, the potential for impingement is related to the volume of water withdrawn, we expect that the number of shortnose sturgeon impinged at the IP1 intakes would be 0.34% of the number of shortnose sturgeon impinged at IP2 and IP3. As explained above, adjusting the long term average by 400%, we expect 16 shortnose sturgeon to be impinged at IP2 and IP3 annually. Assuming that an additional 0.34% would be impinged at the IP1 intake, we would expect an average of 0.05 shortnose sturgeon to be impinged annually at IP1 intakes. Between now and 2033 when the IP2 license expires (a period of 21 years), we would expect one shortnose sturgeon to be impinged at IP1.

In summary, using the average annual impingement from 1974-1990 and adjusting it by 400% to account for increases in the shortnose sturgeon population and then adding 0.34% to account for the IP1 intakes, we would expect a total impingement of 337 shortnose sturgeon between now and September 2033 (the time period when IP2 and IP3 will be operational and water will be withdrawn through the IP1 intakes) and an additional 9 shortnose sturgeon from September 2033-December 2035 when just IP3 will be operational. This results in a total estimate of 346 shortnose sturgeon impinged at Indian Point.

[12] Email from Elise Zoli, representing Entergy, to NMFS and NRC on September 21, 2011.

Calculations based on Entergy's Impingement Density Calculations

Entergy states that some of the interannual variability in impingement is likely due to the variable operation of the facility (i.e., changes in the volume of water withdrawn due to outages). To account for this variable, Entergy developed the impingement density estimate which calculates the average number of sturgeon impinged per month per volume of water removed. Entergy has determined that operations of IP2 and IP3 from 2001-2008 are representative of future operations, including under the terms of the proposed new licenses. Entergy has indicated that there are no power uprates or other changes being proposed at the facility that would result in more water being withdrawn in the future. Therefore, Entergy applied an adjusted impingement density (to account for increases in the shortnose sturgeon population) to the predicted volume of water to be removed in the future (based on 2001-2008 operation), to predict future impingement of shortnose sturgeon.

Entergy predicted future impingement using the impingement density values. They consider the annual average water withdrawal rate for 2001-2008 to be representative of future operations of the Indian Point cooling water intake structures. Because operations vary monthly, with average water withdrawal lower in some months than others, they factored this variability in operations into the calculations. To account for the increase in shortnose sturgeon in the Hudson River, Entergy adjusted the monthly impingement density rates by 400%. They then applied this impingement density rate to the predicted water withdrawal for the future operating period. Using this method, they predict that impingement would vary monthly, with no impingement in June, July and December and a peak in April; in total, this method estimates the impingement of 20 shortnose sturgeon per year (see Figure 4 below).

Figure 4. Among-month pattern of projected average shortnose sturgeon impingement at IP2 and IP3, and average of IP2 and IP3 flows (cooling water plus service water) for the years 2001-2008. From Entergy 2012.

Comparison of results of the two calculation methods
Both of the methods considered above make adjustments to account for the greater number of shortnose sturgeon in the Hudson River now as compared to the number when impingement monitoring occurred. The Entergy method predicts greater numbers of future impingement than just using the average annual impingement rate from 1974-1990. Entergy predicts that future operations will be similar to operations from 2001-2008. During that time, average service and cooling water flows through the IP2 and IP3 intakes ranged from 1 million to 1.8 million gallons per minute depending on the month. From 1976-1990, average service and cooling water flows through the IP2 and IP3 intakes ranged from 0.6-1.2 million gallons per minute depending on the month suggesting an overall increase of 1.5-1.6 times the amount of water to be withdrawn in the future as compared to 1976-1990. If we assume that the risk of impingement increases with the volume of water removed through the intakes, then it becomes important to factor in increased water usage when considering future impingement. If we adjust the calculated impingement number (16; based on the annual average) by a factor of 1.6 to account for increased water usage we would estimate an annual average of 25.6 shortnose sturgeon impinged at IP2 and IP3.

Because of the uncertainty related to the factors associated with impingement rates, it is difficult to determine which estimate is a better predictor of future impingement. The Entergy methodology assumes there will be no impingement of shortnose sturgeon in June, July or

December. However, a review of the impingement data that are available suggests that this may not be a reasonable assumption. For example, two of the 32 impinged shortnose sturgeon were impinged in June (1974 and 1975), which suggests that impingement is likely to occur in June. Because of this, and because we believe that by making adjustments to our estimate to account for increased water usage we are removing the potential for underestimating due to lower water usage in the past, we have determined that the best estimate of future impingement at IP2 and IP3 is 26 shortnose sturgeon per year (rounding 25.6 fish up to whole fish). This estimate is based on the annual average estimate of 4 sturgeon per year during the period of 1974-1990 (exclusive of 1975 when only IP3 was operational) and adjustments made to account for a 400% increase in the number of shortnose sturgeon in the Hudson River now as compared to the time when impingement sampling occurred and a 160% increase to account for increases in the predicted amount of water to be withdrawn in the future as compared to 1976-1990. Using the calculation discussed previously for IP1, we expect the annual average impingement of 0.09 shortnose sturgeon at the IP1 intakes. Therefore, for the time period when IP2 and IP3 will be operational (now through September 2033), we expect the impingement of 548 shortnose sturgeon (26 sturgeon per year for 21 years plus two at IP1). During the time period when just IP3 will be operational (September 2033-December 2035), we expect the impingement of 7 shortnose sturgeon per year. This results in a total estimate of 562 shortnose sturgeon impinged at Indian Point.

Comparison of estimate of impingement of shortnose sturgeon in NMFS 2011 Opinion and this Opinion

In the 2011 Opinion, we estimated that over the 20 year extended operating period, 168 shortnose sturgeon would be impinged at IP1, IP2 and IP3, collectively. We calculated this estimate by first determining the average annual impingement rate at IP2 from 1974-1990 and the average annual impingement rate at IP3 from 1976-1990, which we stated was 1.3 and 0.73, respectively. To account for the 400% increase in the shortnose sturgeon population between the late 1970s and the late 1990s, we adjusted those annual impingement rates by a factor of 4 was 5.2 and 2.9 shortnose sturgeon per year, respectively. We then multiplied those annual estimates by the number of years each unit would be operational (20) to get a total estimate for IP2 of 104 and a total estimate for IP3 of 58. We then used the calculations noted above (6,000gpm/1,746,000gpm) to estimate the amount of impingement at IP1. We estimated the impingement of six additional shortnose sturgeon at IP1. However, it appears that we made a mathematical error (multiplying 162 by 0.034 instead of 0.0034)and that number should have been one, not six.

In reviewing the methodology used in 2011, we now recognize two ways that this resulted in an underestimate of future impingement. First, we relied on the actual observed number of impingements of shortnose sturgeon, not the estimated number of impingements based on collection efficiency. Collection efficiency takes into account the fraction of fish that enter the intake structure but do not make it into impingement collections. According to NRC, currents may sweep some fish around the traveling screens because screens do not form a perfectly water tight seal against the intake structure. NRC has stated that the CE adjusted estimates should be more accurate . We also have new information on the volume of water Entergy is likely to withdraw through the IP2 and IP3 intakes in the future (Entergy 2012). The information provided by Entergy indicates that water withdrawal will range from 1.2-1.6 mgd depending on the month. They report water usage from 1974-1990 as ranging from 0.6-1.2 mgd depending on the month. We expect a relationship between water usage and impingement; the more water that is withdrawn the higher the risk for impingement. Therefore, by not adjusting the historic impingement numbers to account for current and future increases in water use, our 2011 estimate likely underestimates future impingement of shortnose sturgeon. We believe the methodology described above, which avoids that underestimation, and results in a total estimate of 562 shortnose sturgeon impinged at Indian Point is a better approach.

Predicted Mortality of Impinged Shortnose Sturgeon

NRC has stated that the installation of the modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement mortality for shortnose sturgeon. However, because no monitoring occurred after the installation of the Ristroph screens, more recent data are not available and, it is not possible to determine to what extent the modified Ristroph screens may have reduced impingement mortality as compared to pre-1991 levels.

Of the 32 shortnose sturgeon collected during impingement sampling at IP2 and IP3, condition (alive or dead) is reported for nine fish (NRC BA 2010); of these, seven are reported as dead (78% mortality rate). There is no information to indicate whether alive meant alive and not injured, or alive and injured. There is also no additional information to assess whether these fish reported as dead were likely killed prior to impingement and drifted into the intake or whether being in the intake bays and/or impingement was the sole cause of death or a contributing cause of death.

Before installation of modified Ristroph screen systems in 1991, impingement mortality at IP2 and IP3 was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design of the screens, as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at IP2 and IP3. The Fletcher study reported mortality following an 8-hour holding period in an attempt to account for delayed mortality that may result from injuries suffered during impingement. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad, with mortality rates ranging from 9-62%, depending on species. No evaluation of survival of shortnose sturgeon on the modified Ristroph screens at IP2 or IP3 was made and no monitoring has occurred since the screens were installed in 1991.

PSEG prepared estimates of impingement survival following interactions with Ristroph screens at their Salem Nuclear Generating Station located on the Delaware River (PSEG in Seabey and Henderson 2007); survival of shortnose sturgeon was estimated at 60% following impingement on a conventional screen and 80% following survival at a Ristroph Screen; survival for other species ranged from 0-100%. It is important to note that PSEG did not conduct field verifications with shortnose sturgeon to demonstrate whether these survival estimates are observed in the field. A review by NMFS of shortnose sturgeon impingement information at Salem indicates that all recorded impingements (20 total since 1978; NRC 2010) have been at the trash racks, not on the Ristroph screens. This is consistent with the expectation that all shortnose sturgeon in the vicinity of the Salem intakes would be too large to fit through the trash bars and potentially contact the Ristroph screens. Thus, while there is impingement data from Salem, there is no information on post-impingement survival for shortnose sturgeon impinged on the Ristroph screens. The majority of impinged shortnose sturgeon at Salem have been dead at the time of removal from the trash racks (17 out of 20; 85%),

In his 1979 testimony, Dadswell discussed a mortality rate of shortnose sturgeon at traditional screens of approximately 60%, although it is unclear what information this number is derived from as no references were provided and no explanation was given in the testimony. NRC states in their BA that this was based on the percent of shortnose sturgeon alive vs. dead during one year of impingement monitoring that was available at the time.

No further monitoring of the IP2 or IP3 intakes or impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991, and any actual reduction in mortality or injury to shortnose sturgeon resulting from impingement after installation of these systems at IP2 and IP3 has not been established. As explained above, shortnose sturgeon with a body width of at least three inches would not be able to pass through the trash bars and would become impinged on the trash bars and not pass through to the Ristroph screens. Survival for shortnose sturgeon impinged on the trash bars would be dependent on the length of time the fish was impinged and whether it also interacted with debris that collects on the bars. The available data for shortnose sturgeon impingement at trash bars indicates that mortality is likely to be high (e.g., 85% at Salem nuclear facility) even when a monitoring program is in place designed to observe and remove impinged fish[13].

As noted above, healthy shortnose sturgeon (yearlings and older) are expected to be able to readily avoid an intake with an approach velocity of 1.0 fps or less. Some of the shortnose sturgeon impinged may already be dead or suffering from injury or illness. Some sturgeon caught in the buckets of the Ristroph screen may be healthy and free swimming and may experience injury or mortality while being transported to the sluice. Other sturgeon may become impinged on the traveling screens and suffer injury or mortality due to their impingement. Some sturgeon may become injured or die from being in the intake embayment between the trash bars and screens. Past monitoring at IP2 and IP3 indicates that mortality rates are approximately 78% (assuming the best case, that all shortnose sturgeon recorded as "alive" were not just alive but were uninjured), monitoring at the Salem nuclear facility indicates that mortality rates at the trash bars are approximately 85%. With no monitoring or inspection plan in place to detect and remove shortnose sturgeon that become impinged on the trash bars, mortality rates for shortnose sturgeon impinged on the trash bars are more likely to be as high as 100%, as there would be no opportunity for fish to be removed once stuck between or on the bars.

Based on the available information, it is difficult to predict the likely mortality rate for shortnose sturgeon following impingement on the Ristroph screens. Shortnose sturgeon passing through the trash bars and becoming impinged on the Ristroph screens are likely to be small juveniles with body widths less than three inches. Based on the 8-hour survival rates reported by Fletcher for other species, it is likely that some percentage of shortnose sturgeon impinged on the

[13] At Salem, trash racks infront of the intakes are cleaned at least three times per week and the trash bars are inspected every four hours from April through October.

Ristroph screens will survive. Shortnose sturgeon that become impinged on the Ristroph screens may be suffering from injuries, illnesses, or other stressors that have impaired their swimming ability and prevented them from being able to escape from the relatively low approach velocity (1.0 fps or less as measured within the intake bay in front of the Ristroph screens, which yearling and older shortnose sturgeon are expected to be able to avoid (Kynard et al. 2005)). Given the design of the Ristroph screens and the short passage time, it is unlikely that passage through the screen system would increase the likelihood of mortality or exacerbate injury or illness. However, because we do not know the condition of the fish prior to impingement, and we have no site-specific studies to base an estimate or even species-specific studies at different facilities, we will assume the worst case, that mortality is 100%.

Using the impingement rates calculated above, and the worst case mortality rate of 100% at both the modified Ristroph screens and the trash bars, an average of 24 shortnose sturgeon may die each year as a result of impingement at IP2 and IP3. We expect a total of 562 shortnose sturgeon to die as a result of impingement at IP2 and IP3 between now and the time that the extended operating licenses expire. For the reasons given above, we believe that the 100% mortality estimate is a conservative, yet reasonable, mortality rate for impinged shortnose sturgeon at the trash bars and Ristroph screens.

7.1.2.2 Impingement of Atlantic sturgeon at IP2 and IP3

Daily monitoring for sturgeon occurred at IP2 and IP3 from 1974-1990. The actual observed number of impingements is recorded as “Observed Fish” below (called the “Level 5 Count” in NRC 2010 and 2012). This number was adjusted to account for collection efficiency to determine the “Estimated Fish” below (the “CE Adjusted Level 5 Count” in NRC 2010 and 2012).

A total of 601 Atlantic sturgeon were observed during impingement monitoring at IP2 and IP3 from 1974-1990. Adjusting for collection efficiency, it is estimated that a total of 1,334 Atlantic sturgeon were impinged at IP2 and IP3 during this period. For this period, the average number of Atlantic sturgeon impinged per year at IP2 and IP3 was 78.5 Atlantic sturgeon/year (see Table 3 below).

	IP2		***IP3***		
Year	**Observed Fish**	**Estimated Fish**	**Observed Fish**	**Estimated Fish**	**Total IP2 and IP3 Annual Estimate**
1974	101	282	10	17	299
1975	118	302	NR	NR	302
1976	8	17	8	14	31
1977	44	105	153	252	357
1978	16	38	21	31	69
1979	32	75	38	51	126
1980	9	24	10	17	41

1981	3	8	5	7	15
1982	1	2	1	1	3
1983	3	6	0	0	6
1984	3	6	5	10	16
1985	9	19	17	25	44
1986	2	6	5	6	12
1987	2	6	1	2	8
1988	1	2	0	0	2
1989	0	0	0	0	0
1990	0	0	2	3	3
Total	352	**898**	276	**436**	**1334**

To account for interannual variations in operations, Entergy calculated an "impingement density" of sturgeon (see above). For Atlantic sturgeon, on average, the highest impingement occurred in April (approximately 15 per month), with the lowest impingement (less than two per month) occurring in late Fall.

The impingement density values calculated by Entergy are shown for each year 1976 through 1990[14] for Atlantic sturgeon in Figure 5. This figure presents year on the horizontal axis and the vertical axis shows the annual sturgeon impingement density (sturgeon per million gpm) for IP2 and IP3 combined. The annual sturgeon impingement density shown on the vertical axis of Figure 5 is calculated as the annual number (count) of sturgeon impinged and then scaled upward by monthly collection efficiency values for each Unit in each year and divided by the annual average cooling water withdrawal rate for that Unit and year in million gallons per minute. The impingement density values plotted on the vertical axis in Figure 6 represents the sum of each density value for IP2 and IP3 for each year.

Annual Atlantic sturgeon impingement density (average of monthly estimates of impingement density based on number impinged and the average monthly flow rate) ranged from 0 (1989) to 54 (1977).

[14] Entergy used the years 1976-1990 for this method because those were the years that flow data was available. Also, IP3 was not operational in 1975.

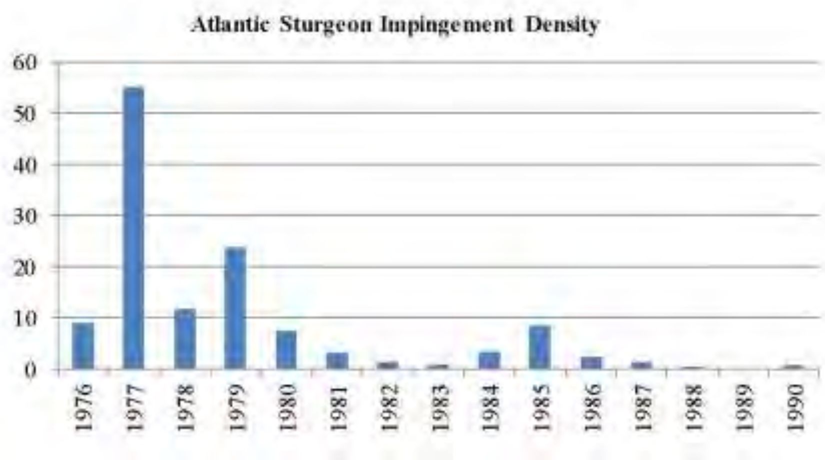


Figure 5. Among year pattern of Atlantic sturgeon impingement density at IP2 and IP3 (combined). Annual density is the average of monthly estimates of impingement density based on number impinged and the average monthly flow rate (million gpm). From Entergy 2012.

Figure 6. Among-month pattern of average Atlantic sturgeon impingement at IP2 and IP3, and average flows (cooling water plus service water) for the years 1976-1990.

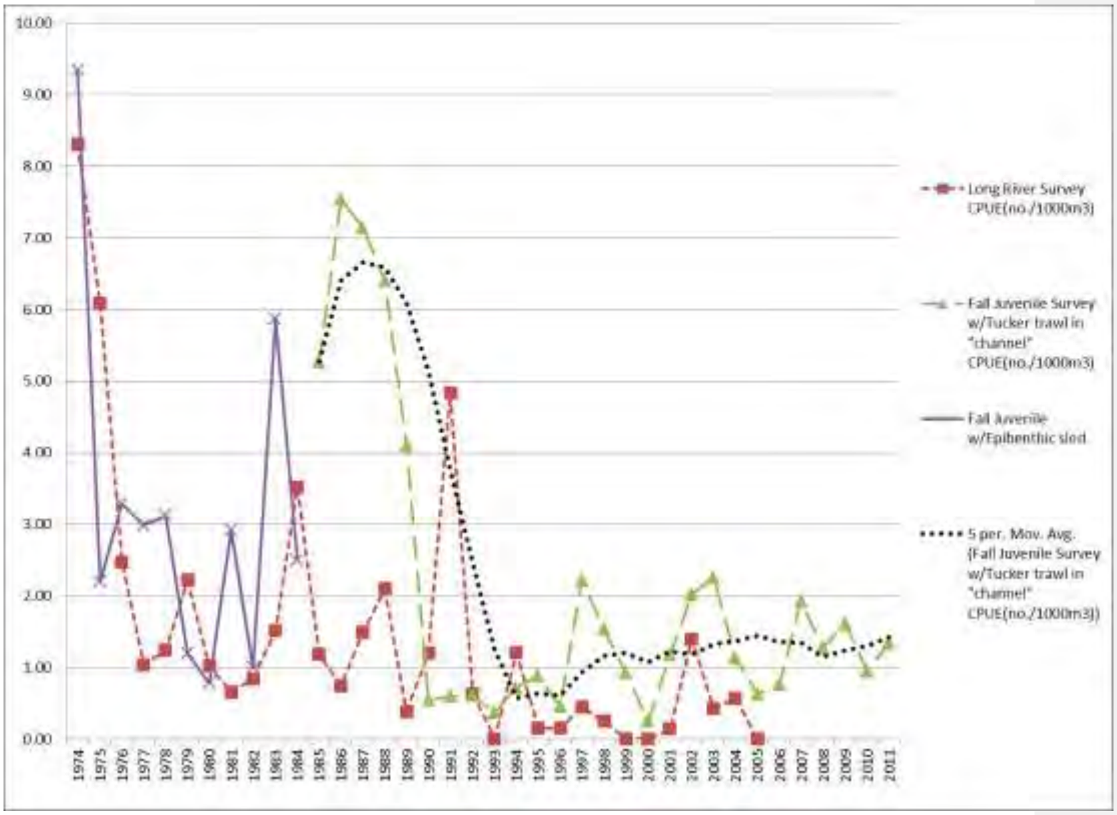
Predicted Future Impingement of Atlantic Sturgeon at IP2 and IP3
We examined the available data on Atlantic sturgeon impinged at IP2 and IP3 to determine the length of impinged fish. Of the 601 Atlantic sturgeon recorded at IP2 and IP3 from 1974-1990, length is available for 36 individuals. These fish ranged in size from 14-79 cm. Like shortnose sturgeon, this is consistent with our estimates of the size of fish that would be able to pass through the trash bars but is larger than the size of fish we would expect to be vulnerable to impingement.

We examined condition information to determine if there was an indication that these fish were sick or injured. We expect fish that are sick or injured to have reduced swimming speed or endurance and that they may not be able to avoid impingement the way a healthy fish would. Unfortunately, the data that is available on the 601 impinged Atlantic sturgeon only indicates condition (alive or dead) for 37 individuals (the same ones that had length recorded plus one additional). Of these 37 fish, 22 were dead; however, there does not appear to be a relationship between the length of the fish and whether they were alive or dead.
Like shortnose, based on the size of the Atlantic sturgeon that have been impinged at IP2 and IP3 and the analysis completed by Entergy, it appears that there are other factors than the size of the fish that are contributing to the likelihood of impingement. We expect that the factors discussed above for shortnose (i.e,. "active" capture of fish by the buckets on the Ristroph screens, possible impairment due to illness or injury, disorientation or exhaustion due to being "trapped" between the trash racks and Ristroph screens, conditions in the area including water temperature), also contribute to the likelihood that Atlantic sturgeon are impinged and would explain why fish that are of sufficient size to avoid impingement at the reported velocities would still be impinged.

The impingement of sturgeon at IP2 and IP3 is probably due to a combination of the factors mentioned above, all of which explain how impingement can occur despite reported intake velocities at levels that are below those that most sturgeon should be able to readily escape from. Despite the low intake velocity reported by Entergy, impingement of Atlantic sturgeon occurred in the past and likely continues to occur. The lack of recent monitoring data makes predictions of future impingement more difficult. Estimating future impingement is made more difficult by the variability in annual impingement rates and not knowing the degree to which factors discussed above contribute to these differences. Like we did for shortnose sturgeon, we have considered several ways to estimate likely future impingement of Atlantic sturgeon including: (1) using the annual average number of impingements to predict future impingement; and (2) using Entergy's impingement density calculations.

Calculations based on Impingement data from 1974-1990
During the period that impingement sampling occurred, the number of Atlantic sturgeon impinged ranged from zero to 357. The average annual impingement was 78.4 Atlantic sturgeon/year. Excluding 1975, when only IP2 was operational, the average was 60.8 per year. As noted in the Status of the Species section of this Opinion, the Atlantic sturgeon population in the Hudson River has had a decreasing trend over the time period that impingement monitoring occurred. Therefore, we considered if the average impingement rate during 1974-1990 would overestimate future impingement.

We have made the basic assumption that the risk of impingement increases with the size of the population. That is, we expect that if there are more fish in the river there is more opportunity for individuals to be impinged. We expect if there are more sturgeon in the action area then the impingement rate would be higher. As evidenced by estimates of juvenile abundance, the Atlantic sturgeon population in the Hudson River has declined over time. Peterson et al. (2000) found that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. Similarly, longterm indices of juvenile abundance (the Hudson River Long River and Fall Shoals surveys) demonstrate a longterm declining trend in juvenile abundance. The figure below (Figure 7) illustrates the CPUE of Atlantic sturgeon in the two longterm surveys of the Hudson River. Please note that the Fall Shoals survey switched gear types in 1985. We do not have the CPUE data for the Long River Survey for 2006-2011.



As evidenced in the above table, impingement of Atlantic sturgeon declined over time. The annual average impingement from 1974-1978 was 211.6 Atlantic sturgeon; from 1986-1990 it was 5. Unlike for shortnose sturgeon where the impingement trend did not seem to match the trend of the population, the decline in Atlantic sturgeon in the river appears to be reflected in the declining trend in impingements of Atlantic sturgeon over time. This could be due to the time period of impingement monitoring better reflecting the time when changes were experienced in the Atlantic sturgeon population than changes in the shortnose sturgeon population.

CPUE for the Fall Juvenile Survey for the most recent five year period (2007-2011) is approximately 27% of the CPUE from 1985-1990 (1.41 compared to 5.17). The CPUE results suggest a sharp decline in juvenile Atlantic sturgeon in the Hudson River after 1989. While the CPUE results only indicate trends for juvenile Atlantic sturgeon, given the size of the Atlantic sturgeon impinged at Indian Point, they are a good representative of the year classes affected by operations of Indian Point. Therefore, while we do not have an index of the Hudson River population as a whole, that type of index may not be relevant for considering the number of Atlantic sturgeon available for impingement at Indian Point. Because of the change in gear type, we cannot directly compare CPUE from 1974-1990 (when impingement monitoring occurred) to CPUEs for more recent time periods. The only CPUEs that overlap with the impingement monitoring that can be directly compared to current CPUEs are those from 1985-1990. However, as evidenced in the figure above, there was an overall declining trend in the number of juvenile Atlantic sturgeon in the Hudson River since the mid-1970s. This declining trend is reflected in declines in impingement at Indian Point. CPUE data from 2007-2011 iss more than two times higher than the CPUE from 1991-1996 which may be suggestive of an increasing trend in juvenile abundance. However, the index suggests that numbers of juveniles are still significantly lower now than during the end of the impingement monitoring period. Given the high variability between years, it is difficult to use this data to assess short term trends, however, when looking at a five-year moving average, the index appears to be increasing from lows in the early 1990s, but is still much lower than the 1970s and 1980s.

Based on the CPUE, there appear to be approximately 27% of the number of Atlantic sturgeon juveniles in the Hudson River now as compared to the period 1985-1990. During that period, the average annual impingement rate was 6 Atlantic sturgeon per year. Using the CPUE to adjust that rate to predict current abundance, we would expect an annual average impingement rate of 1.62 Atlantic sturgeon per year. As noted above, there are some indications that the trend in juvenile abundance is increasing. The period 1985-1990 captures the period just prior to the sharp decline in Atlantic sturgeon juvenile abundance. Because there is some evidence of an increasing trend in juveniles in the Hudson River, it is possible that by reducing the average impingement rate from 1985-1990 we could underestimate future impingement.

Entergy conducted an analysis to determine if there was a statistically significant correlation between reported Atlantic sturgeon population size and impingement density. We would expect that the more sturgeon there were in the river, the higher the impingement density would be because there would be more sturgeon that had the potential to be impinged. However, the analysis does not reveal a statistically significant correlation (Entergy 2012). It is likely that this lack of statistical correlation is not due to the fact that there is no relationship between population size and impingement but because impingement of sturgeon is a rare event and because of the high interannual variability in impingement numbers which makes detection of a statistically significant correlation difficult.

We considered reviewing impingement data for other Hudson River power plants to determine if this predicted correlation between decreases in individuals and increased impingement of individuals would be observed. Long term sturgeon impingement monitoring is only available for the Roseton and Danskammer facilities. However, since 2000, both facilities have operated at reduced rates and there has been minimal sturgeon impingement; in every year it has been no more than one. As the Roseton and Danskammer facilities are not currently operating in the same capacity they were in the past, it is not possible to make an accurate comparison of past and present impingement which could serve to determine if it was reasonable to assume that an increase in impingement would occur in association with any change in the number of Atlantic sturgeon in the Hudson River. As noted above, the Lovett facility has been closed. The Bowline facility has always operated with extremely low levels of impingement, thought to be primarily due to the location of the intakes in a nearly enclosed embayment of the River where Atlantic sturgeon are thought to be unlikely to occur (Bowline Pond) (NMFS 2000). Therefore, we are not able to use information from other power intakes to determine if there is an association between changes in population size and rates of impingement.

We also considered examining relationships between population trend and impingement rates at facilities outside the Hudson River. Monitoring of shortnose sturgeon impingement at the Salem Nuclear Generating Station, on the Delaware River, has been ongoing since 1978. However, reporting of impinged Atlantic sturgeon only began in 2010, with one impingement recorded to date. Because of the lack of data, it is not possible to use this information to determine if changes in population size are related to changes in impingement rates.

Despite the uncertainty in determining the factors that are related to impingement, the assumption that the more sturgeon there are in the river the higher the potential for impingement, is reasonable. Because we expect fewer Atlantic sturgeon in the river now than during the period of impingement monitoring we considered adjusting the annual impingement value by 72% (the decrease in juveniles suggested by the CPUE from the Fall Shoals Survey). However, by doing this we may be underestimating future impingement if Atlantic sturgeon juvenile abundance is increasing in the way the Fall Shoals Survey CPUE suggests (i.e., an increase from the early 1990s, but still depressed from the 1970s). Based on what we know about Atlantic sturgeon in the river, the impingement rates from 1985-1990 appear to be the most reflective of future impingement rates. Using the annual average of Atlantic sturgeon impinged during this period, we would anticipate the impingement of an average of 6 Atlantic sturgeon per year at IP2 and IP3 (combined) during the period that these facilities will continue to operate. From September 2033 – December 2035, only IP3 will be operational. During the period 1974-1990, approximately 33% of the impinged Atlantic sturgeon were at IP3. Using that ratio and applying it to the estimate of 6 Atlantic sturgeon when both facilities are operational, we expect an average of 2 Atlantic sturgeon to be impinged annually when just IP3 is operational. Over the two year period we expect the impingement of 4 Atlantic sturgeon.

As described above for shortnose sturgeon, we also need to account for impingement of Atlantic sturgeon at IP1. Using the methodology discussed above, we assume that an additional 0.34% would be impinged at the IP1 intake; therefore, we would expect an average of 0.02 Atlantic sturgeon to be impinged annually at IP1 intakes. Between now and 2033 when the IP2 license expires (a period of 21 years), we would expect one Atlantic sturgeon to be impinged at IP1.

In summary, using the average annual impingement from 1985-1990 and then adding 0.34% to account for the IP1 intakes, we would expect a total impingement of 127 Atlantic sturgeon between now and September 2033 (the time period when IP2 and IP3 will be operational and water will be withdrawn through the IP1 intakes) and an additional 4 Atlantic sturgeon from September 2033-December 2035 when just IP3 will be operational. This results in a total estimate of 131 Atlantic sturgeon impinged at Indian Point.

Calculations based on Entergy's Impingement Density Calculations
Entergy applied an adjusted impingement density (to account for decreases in the Atlantic sturgeon population) to the predicted volume of water to be removed in the future (based on 2001-2008 operation), to predict future impingement of Atlantic sturgeon.

Entergy predicted future impingement using the impingement density values. They consider the annual average water withdrawal rate for 2001-2008 to be representative of future operations of the Indian Point cooling water intake structures. Because operations vary monthly, with average water withdrawal lower in some months than others, they factored this variability in operations into the calculations. To account for the decrease in Atlantic sturgeon in the Hudson River, Entergy adjusted the monthly impingement density rates by reducing them 80%. This was based on Peterson et al. (2000) finding that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. They then applied this impingement density rate to the predicted water withdrawal for the future operating period. Using these rates to estimate future impingement, Entergy predicted an annual average impingement rate of 11.45 individuals per year.

Figure 8. Among-month pattern of projected average Atlantic sturgeon impingement at IP2 and IP3, and average of IP2 and 3 flows (cooling water plus service water) for the years 2001-2008. From Entergy 2012.

Comparison of results of the two calculation methods

Both of the methods considered above make adjustments to account for the lesser number of Atlantic sturgeon in the Hudson River now as compared to the number when impingement monitoring occurred. The Entergy method predicts an annual average impingement rate of 11.4 Atlantic sturgeon per year. Our method, using the average impingement rate from 1985-1990, predicts an annual average rate of 6 Atlantic sturgeon per year. Entergy predicts that future operations will be similar to operations from 2001-2008. During that time, average service and cooling water flows through the IP2 and IP3 intakes ranged from 1 million to 1.8 million gallons per minute depending on the month. From 1976-1990, average service and cooling water flows through the IP2 and IP3 intakes ranged from 0.6-1.2 million gallons per minute depending on the month suggesting an overall increase of 1.5-1.6 times the amount of water to be withdrawn in the future as compared to 1976-1990. If we assume that the risk of impingement increases with the volume of water removed through the intakes, then it becomes important to factor in increased water usage when considering future impingement. If we adjust the calculated impingement number (6; based on the annual average from 1985-1990) by a factor of 1.6 to account for increased water usage we would estimate an annual average of 9.6 Atlantic sturgeon impinged at IP2 and IP3.

Because of the uncertainty related to the factors associated with impingement rates, it is difficult to determine which estimate is a better predictor of future impingement. The Entergy methodology assumes an 80% reduction in impingement in the future as compared to the time when monitoring took place. Based on comparisons of CPUE from 1985-1990 as compared to 2007-2011, it appears that at 72% reduction may be more reasonable. The two estimates result in very similar results, differing by an average of less than two Atlantic sturgeon per year. Entergy's estimate factors in impingement density from the 1970s when impingement rates were very high. That difference likely accounts for the differences in our predicted annual impingement. However, we believe that our estimate is a reasonable predictor of future Atlantic sturgeon impingement. This estimate is based on the annual average estimate of 6 Atlantic sturgeon per year during the period of 1985-1990 and a 160% increase to account for increases in the predicted amount of water to be withdrawn in the future as compared to 1976-1990. Using the calculation discussed previously for IP1, we expect the annual average impingement of 0.02 Atlantic sturgeon at the IP1 intakes. Therefore, for the time period when IP2 and IP3 will be operational (now through September 2033), we expect the impingement of an average of 10 Atlantic sturgeon per year (rounding up 9.6 to 10 to account for whole fish) plus one at IP1 for a total of 211 Atlantic sturgeon. During the time period when just IP3 will be operational (September 2033-December 2035), we expect the impingement of 4 Atlantic sturgeon per year. This results in a total estimate of 219 Atlantic sturgeon impinged at Indian Point.

As explained in section 4.2.2, we have determined that Atlantic sturgeon in the action area likely originate from three of the five DPSs at the following frequencies: NYB 92%; Gulf of Maine 6%; and, Chesapeake Bay 2%. However, it is important to note that only subadults and adults leave their natal rivers. Therefore, any young of the year or juveniles that are impinged would originate from the Hudson River and the New York Bight DPS. We can identify the life stage of Atlantic sturgeon by length. Subadults may move to coastal waters once reaching lengths of approximately76-92 cm (Murawski and Pacheco 1977; Smith 1985).

From 1985 through 1990, lengths (mm total length, "mmTL") and weights (wet weight in grams) of impinged Atlantic sturgeon were reported at IP2 and IP3; however, from 1974-1984, weights were reported but lengths were not. Therefore, for 1974-1984, Entergy predicted lengths of impinged Atlantic sturgeon based on reported weights of impinged Atlantic sturgeon. The prediction equation (R^2=0.85) was developed from length and weight measurements obtained from 36 Atlantic sturgeon collected during impingement sampling from 1985-1990 (Figure 9 below).

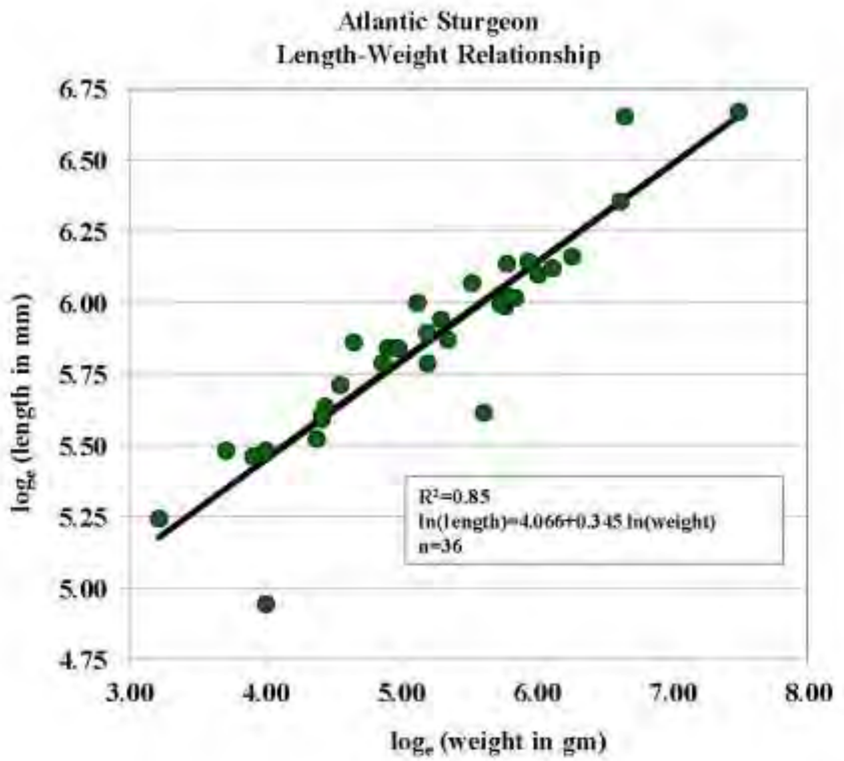


Figure 9. Atlantic sturgeon length-weight relationship based on length (mm TL) and weight measurements (dots) recorded on 36 Atlantic sturgeon collected during impingement sampling at IP2 and IP3 from 1985-1990.

In addition, measurements on greatest body width (mm) and depth (mm) from Atlantic sturgeon collected in FSS and striped bass mark-recapture sampling programs from July through December 2011 were used to predict the longest Atlantic sturgeon that would fit through the 3" wide opening of the bar racks, and could be impinged at IP2 or IP3. Applying this approach, the longest Atlantic sturgeon that would not be excluded by the bar racks, i.e., that could fit between the bars regardless of orientation, would be approximately 600 mmTL.

The length frequency distributions for impinged Atlantic sturgeon (Figure 9) show a median length of approximately 330 mmTL, with a 10th percentile of approximately 200 mmTL and a 90th percentile of approximately 500 mmTL. Although the median length of Atlantic sturgeon collected by 35 foot otter trawls in the Hudson River in 1978 was almost 600mm (Dovel and Berggren, 1980), only 2.5% of impinged Atlantic sturgeon were greater than 600 mmTL, which supports the conclusion that Atlantic sturgeon larger than 600 mmTL are excluded from impingement on the Ristroph screens by the bar racks.

Of the 36 impinged Atlantic sturgeon where length was recorded, only two were longer than 76cm and could have been migrants from outside the Hudson River. However, given their size (77 and 78 cm) at the low end of the range at which coastal migrations begin (76-92 cm) and the time of year that they were impinged (February 14 and March 13) it is likely that these two fish originated from the Hudson River.

Based on the available information on past impingements and the predicted size of individuals that will be impinged in the future, it is likely that all impingements will be of young of year, juveniles and subadults originating from the Hudson River. Therefore, we expect all individuals impinged to originate from the New York Bight DPS.

Predicted Mortality of Impinged Atlantic Sturgeon
NRC has stated that the installation of the modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement mortality for sturgeon. However, because no monitoring occurred after the installation of the Ristroph screens, more recent data are not available and, it is not possible to determine to what extent the modified Ristroph screens may have reduced impingement mortality as compared to pre-1991 levels.

Of the 601 Atlantic sturgeon collected during impingement sampling at IP2 and IP3, condition (alive or dead) is reported for 37 fish (NRC BA 2012); of these, 22 are reported as dead (59% mortality rate). There is no information to indicate whether alive meant alive and not injured, or alive and injured. There is also no additional information to assess whether these fish reported as dead were likely killed prior to impingement and drifted into the intake or whether being in the intake bays and/or impingement was the sole cause of death or a contributing cause of death.

Before installation of modified Ristroph screen systems in 1991, 100 percent impingement mortality at IP2 and IP3 was assumed. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design of the screens, as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at IP2 and IP3. The Fletcher study reported mortality following an 8-hour holding period in an attempt to account for delayed mortality that may result from injuries suffered during impingement. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad, with mortality rates ranging from 9-62%, depending on species. No evaluation of survival of Atlantic sturgeon on the modified Ristroph screens at IP2 or IP3 was made and no monitoring has occurred since the screens were installed in 1991.

No further monitoring of the IP2 or IP3 intakes or impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991, and any actual reduction in mortality or injury to Atlantic sturgeon resulting from impingement after installation of these systems at IP2 and IP3 has not been established. As explained above, Atlantic sturgeon with a body width of at least three inches would not be able to pass through the trash bars and would become impinged on the trash bars and not pass through to the Ristroph screens. Survival for Atlantic sturgeon impinged on the trash bars would be dependent on the length of time the fish was impinged and whether it also interacted with debris that collects on the bars. Assuming that shortnose and Atlantic sturgeon mortality rates are similar, we expect that the mortality of Atlantic sturgeon at trash is likely to be high (e.g., 85% for shortnose sturgeon at Salem nuclear facility) even when a monitoring program is in place designed to observe and remove impinged fish.

As noted above, healthy Atlantic sturgeon (yearlings and older) are expected to be able to readily avoid an intake with an approach velocity of 1.0 fps or less. Therefore, any Atlantic sturgeon impinged at the trash bars, where the velocity is 1.0 fps or less depending on operating condition, are likely to already be suffering from injury or illness which has impaired their swimming ability. Past monitoring at IP2 and IP3 indicates that mortality rates for Atlantic sturgeon are approximately 60%, monitoring at the Salem nuclear facility indicates that mortality rates at the trash bars are approximately 85% for shortnose sturgeon. With no monitoring or inspection plan in place to detect and remove Atlantic sturgeon that become impinged on the trash bars, mortality rates for Atlantic sturgeon impinged on the trash bars are more likely to be as high as 100%, as there would be no opportunity for fish to be removed once stuck between or on the bars.

Based on the available information, it is difficult to predict the likely mortality rate for Atlantic sturgeon following impingement on the Ristroph screens. Atlantic sturgeon passing through the trash bars and becoming impinged on the Ristroph screens are likely to be small juveniles or subadults with body widths less than three inches. Based on the 8-hour survival rates reported by Fletcher for other species, it is likely that some percentage of Atlantic sturgeon impinged on the Ristroph screens will survive. Atlantic sturgeon that become impinged on the Ristroph screens may be suffering from injuries, illnesses, or other stressors that have impaired their swimming ability and prevented them from being able to escape from the relatively low approach velocity (1.0 fps or less as measured within the intake bay in front of the Ristroph screens, which yearling and older Atlantic sturgeon are expected to be able to avoid. Given the design of the Ristroph screens and the short passage time, it is unlikely that passage through the screen system would increase the likelihood of mortality or exacerbate injury or illness. However, because we do not know the condition of the fish prior to impingement, and we have no site-specific studies to base an estimate or even species-specific studies at different facilities, we will assume the worst case, that mortality is 100%.

Using the impingement rates calculated above, and the worst case mortality rate of 100% at both the modified Ristroph screens and the trash bars, an average of 10 Atlantic sturgeon may die each year as a result of impingement at IP2 and IP3. As such, we expect a total of 265Atlantic sturgeon to die as a result of impingement at IP2 and IP3 between now and the time that the extended operating licenses expire. For the reasons given above, we believe that the 100% mortality estimate is a conservative, yet reasonable, mortality rate for impinged Atlantic sturgeon at the trash bars and Ristroph screens. As noted above, we expect all impinged Atlantic sturgeon to originate from the Hudson River and the New York Bight DPS. Therefore, we expect the mortality of 219 New York Bight DPS Atlantic sturgeon between now and December 15, 2035.

7.1.3 Effects of Impingement and Entrainment on Shortnose and Atlantic sturgeon prey

Shortnose and Atlantic sturgeon feed primarily on benthic invertebrates. As these prey species are found on the bottom and are generally immobile or have limited mobility and are not within the water column, they are less vulnerable to impingement or entrainment. Impingement and entrainment studies have not included macroinvertebrates as focus species. No macroinvertebrates are represented in the Representative Important Species (RIS) species focused on by NRC in the FSEIS. However, given the life history characteristics (sessile, benthic, not suspended in or otherwise occupying the water column) of shortnose and Atlantic sturgeon forage items which make impingement and entrainment unlikely, any loss of sturgeon prey due to impingement or entrainment is likely to be minimal. Therefore, we have determined that the effect on shortnose and Atlantic sturgeon due to the potential loss of forage items caused by impingement or entrainment in the IP1, IP2 or IP3 intakes is insignificant and discountable.

7.1.4 Summary of Effects of Water Withdrawal

IP2 and IP3 currently operate pursuant to operating licenses issued by NRC; this will continue until a licensing decision is made. If new licenses are issued as proposed, IP2 and IP3 will continue to operate with once through cooling until September 29, 2033 and December 12, 2035 respectively. The extended operation of IP2 and IP3 would be authorized by the NRC through the issuance of renewed operating licenses. Compliance with the Clean Water Act provisions is a condition of the existing licenses and will be a condition of any new licenses issued.

In the analysis outlined above, we determined the impingement of shortnose sturgeon is likely to occur at IP2 and IP3 while IP2 and IP3 continue to operate as well as at the IP1 intake which will be used for withdrawing service water for the operation of IP2. We estimate, using the impingement and mortality rates calculated above, that each year an average of 24 shortnose sturgeon may die as a result of impingement at the Indian Point facility, for a total of 562 shortnose sturgeon mortalities between now and December 12, 2035. We also estimate that an average of 10 Atlantic sturgeon will be impinged and die each year, for a total of 219 Atlantic sturgeon mortalities between now and December 12, 2035. All of these Atlantic sturgeon are likely to originate from the Hudson River and the New York Bight DPS. We believe that the 100% mortality estimate is a conservative, yet reasonable estimate of the likely mortality rate for impinged shortnose sturgeon at the Ristroph screens. Due to the size of shortnose and Atlantic sturgeon that occur in the action area, no entrainment at any of the IP intakes is anticipated. Any effects to shortnose or Atlantic sturgeon prey from the continued operation of IP2 and IP3, as defined by the proposed action, would be insignificant and discountable.

7.2 Effects of Discharges to the Hudson River

The discharge of pollutants from the IP facility is regulated for CWA purposes through the New York SPDES program. The SDPES permit (NY-0004472) specifies the discharge standards and monitoring requirements for each discharge. Under this regulatory program, Entergy treats wastewater effluents, collects and disposes of potential contaminants, and undertakes pollution prevention activities. Compliance with the SPDES permit is a condition of the existing operating licenses and will be a condition of any new operating licenses issued for IP2 and IP3.

As explained above, Entergy's 1987 SPDES permit remains in effect while NYDEC administrative proceedings continue on a new draft permit. As such, pursuant to NRC's consultation request, the effects of the IP facility continuing to operate under the terms of the existing licenses and the proposed renewed licenses and under the terms of the 1987 SPDES permit will be discussed below.

7.2.1 Heated Effluent

As indicated above, the extended operation of IP2 and IP3 will be regulated by the NRC through the issuance of renewed operating licenses. Given the facilities with a once-through cooling water system cannot operate without the intake and discharge of water, and any limitations or requirements necessary to assure compliance with applicable Clean Water Act provisions would be conditions of the proposed renewed licenses, the effects of discharges are effects of the proposed action. This is also true for the existing licenses under which the facility will operate until NRC makes a licensing decision. The discharges would not occur but for the operation of the facilities.

Thermal discharges associated with the operation of the once through cooling water system for IP2 and IP3 are regulated for CWA purposes by the terms of the SPDES permit. Temperature limitations are established and imposed on a case-by-case basis for each facility subject to NYCRR Part 704. Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR Part 704 as follows:

(5) Estuaries or portions of estuaries.

- i. The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point.
- ii. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or a maximum of 83°F, whichever is less.
- iii. From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than an 83°F increase in temperature not to exceed 1.5°F at any point of the estuarine passageway as delineated above, may be permitted.
- iv. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than 4°F from the temperature that existed immediately prior to such lowering.

Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified by NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110°F (43°C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2°F (34°C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2°F (34°C) on more than 15 days during that period in any year.

The discharge of heated water has the potential to cause lethal or sublethal effects on fish and other aquatic organisms and create barriers, preventing or delaying access to other areas within the river. Limited information is available on the characteristics of the thermal plume associated with discharges from IP2 and IP3. As water withdrawn through the IP1 intakes will be used for service water, not cooling water, the discharge of this water is not heated. Below, NMFS summarizes the available information on the thermal plume, discusses the thermal tolerances of shortnose sturgeon, and considers effects of the plume on shortnose sturgeon, Atlantic sturgeon and their prey.

7.2.1.1 Characteristics of Indian Point's Thermal Plume

Thermal studies at IP2 and IP3 were conducted in the 1970s. These studies included thermal modeling of near-field effects using the Cornell University Mixing Zone Model (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology (MIT) dynamic network model (also called the far-field thermal model). For the purpose of modeling, near-field was defined as the region in the immediate vicinity of each station discharge where cooling water occupies a clearly distinguishable, three-dimensional temperature regime in the river that is not yet fully mixed; far-field was defined as the region farthest from the discharges where the plumes are no longer distinguishable from the river, but the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed sufficient by the utilities and their contractor and was designed and configured to account for time-variable hydraulic and meteorological conditions and heat sources of artificial origins. Model output included a prediction of temperature distribution for the Hudson River from the Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the permit applicants applied CORMIX modeling to develop a three-dimensional plume configuration of near-field thermal conditions that could be compared to applicable water quality criteria.

The former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September. These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

i. Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.
ii. Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each station, and concurrent operation of all three generating stations at maximum permitted capacity

(CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX model runs were integrated with the riverwide temperature profiles developed by the MIT dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises above ambient) for various operating scenarios, the surface width of the plume, the depth of the plume, the percentage of surface width relative to the river width at a given location, and the percentage of cross-sectional area bounded by the 4°F (2°C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999). For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86°F (1.18 to 1.59°C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4°F (2°C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24°F (1.80°C) during June ebb tides to 4.63°F (2.57°C) during flood tides in August. Temperature increases exceeded 4°F (2°C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4°F (2°C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events.

Exceedences generally occurred under scenarios that Entergy indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding, CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

Information provided by Entergy during the consultation period indicates that the CORMIX model has significant limitations which limit its utility when considering the discharge of heated effluent into the Hudson River. Specifically, the CORMIX model results in an overestimate of the scope and extent of the thermal plume. As more recent information on the thermal plume is available (see below) and this new information has been reviewed by NYDEC and determined to be appropriate to use when considering the effects of the thermal discharge on the Hudson River, NMFS is not relying on the CORMIX model in our effects analysis, but rather is relying on the more recent triaxial thermal plume study described below.

More recently, a triaxial thermal plume study was completed. Swanson et al. (2011 b) conducted thermal sampling and modeling of the cooling water discharge at Indian Point and reported that the extent and shape of the thermal plume varied greatly, primarily in response to tidal currents. For example, the plume (illustrated as a 4°F temperature increase or LH isotherm, Figure 5-6 in Swanson et al. 2011 b) generally followed the eastern shore of the Hudson River and extended northward from Indian Point during flood tide and southward from Indian Point during ebb tide. Depending on tides, the plume can be well-defined and reach a portion of the near-shore bottom or be largely confined to the surface.

Temperature measurements reported by Swanson et al. (2011 b) generally show that the warmest water in the thermal plume is close to the surface and plume temperatures tend to decrease with depth. Occasionally, the thermal plume extends deeply rather than across the surface. A cross-river survey conducted in front of Indian Point captured one such incident during spring tide on July 13, 2010 (Figure 3-28 in Swanson et al. 2011b). Across most of the river, water temperatures were close to 82°F (28°C), often with warmer temperatures near the surface and cooler temperatures near the bottom. The Indian Point thermal plume at that point was clearly defined and extended about 1000 ft (300 m) from shore. Surface water temperatures reached about 85°F (29°C). At 23-ft to about 25-ft (7-m to 8-m) depths, observed plume temperatures were 83° to 84°F (28° to 29°C). Maximum river depth along the measured transect is approximately 50 ft (15 m).

A temperature contour plot of a cross-river transect at Indian Point prepared in response to a NYSDEC review illustrates a similar condition on July 11, 2010 during slack before flood tide (Swanson et al. 2011a, Figure 1-10). Here the thermal plume is evident to about 2000 ft (600 m) from the eastern shore (the location of the Indian Point discharge) and extends to a depth of about 35 ft (11 m) along the eastern shore. Bottom temperatures above 82°F (28°C), were confined to about the first 250 ft (76 m) from shore. The river here is over 4500 ft (1400 m) wide. In that small area, bottom water temperatures might also exceed 30°C (86°F); elsewhere, bottom water temperatures were about 80°F (27°C). These conditions would not last long, however, as they would change with the tidal cycle. Under no conditions did interpolated temperatures in Entergy's modeled results exceed the 28°C in the deep reaches of the river channel (Swanson 2011 a).

In response to the NYSDEC's review of the Indian Point thermal studies (Swanson et al. 2011 b), Mendelsohn et al. (2011) modeled the maximum area and width of the thermal plume (defined by the 4°F (2°C) ΔT isotherms) in the Hudson River. Mendelsohn, et al. reported that for four cross-river transects near IP2 and IP3, the maximum cross-river area of the plume would not exceed 12.3 percent and the maximum cross-river width of the plume would not exceed 28.6 percent of the river (Mendelsohn, et al.'s Table 3-1).

7.2.1.2 Thermal Tolerances – Shortnose sturgeon

Most organisms can acclimate (i.e. metabolically adjust) to temperatures above or below those to which they are normally subjected. Bull (1936) demonstrated, from a range of marine species, that fish could detect and respond to a temperature front of 0.03 to 0.07°C (0.05 – 0.13°F). Fish will therefore attempt to avoid stressful temperatures by actively seeking water at the preferred temperature.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F)(Dadswell et al. 1984) and as high as 27-30°C in the Connecticut River (Dadswell et al. 1984) and 34ºC in the Altamaha River, Georgia (93.2°F) (Heidt and Gilbert 1978). Foraging is known to occur at temperatures greater than 7°C (44.6°F) (Dadswell 1979). In the Altamaha River, temperatures of 28-30ºC (82.4-86°F) during summer months are correlated with movements to deep cool water refuges. Some information specific to the Hudson River is available. Smith (1985 in Gilbert 1989) reports that juvenile Atlantic sturgeon were most common in areas where water temperatures were 24.2-24.7°C. Haley (1999) conducted studies on the distribution of Atlantic and shortnose sturgeon in the Hudson River in 1995 and 1996. Water temperatures at capture locations were recorded. Atlantic sturgeon were found in warmer areas than shortnose sturgeon. The mean temperature of areas where Atlantic sturgeon were present was 25.6°C (s.d. +/- 2.0); the mean temperature for shortnose sturgeon was 24.34°C (s.d. +/- 2.8°C.

Ziegeweid et al. (2008a) conducted studies to determine critical and lethal thermal maxima for young-of-the-year (YOY) shortnose sturgeon acclimated to temperatures of 19.5 and 24.1°C (67.1 – 75.4°F). These studies were carried out in a lab with fish from the Warm Springs National Fish Hatchery (Warm Springs, Georgia). The fish held at this fish hatchery were reared from broodstock collected from the Altamaha and Ogeechee rivers in Georgia. Lethal thermal maxima were 34.8°C (±0.1) and 36.1°C (±0.1) (94.6°F and 97°F) for fish acclimated to 19.5 and 24.1°C (67.1°F and 75.4°F), respectively. The acclimation temperature of 24.1°C is similar to the temperature where shortnose and Atlantic sturgeon juveniles were most often found in the Hudson River (24.1°C) suggesting that this it is reasonable to rely on these results for assessing effects to Hudson River sturgeon. However, it is important to note that there may be physiological differences in sturgeon originating from different river systems. Fish originating from southern river systems may have different thermal tolerances than fish originating from northern river systems. However, the information presented in this study is currently the best available information on thermal maxima and critical temperatures for shortnose sturgeon. The study also used thermal maximum data to estimate upper limits of safe temperature, final thermal preferences, and optimum growth temperatures for YOY shortnose sturgeon. Visual observations suggest that fish exhibited similar behaviors with increasing temperature regardless of acclimation temperature. As temperatures increased, fish activity appeared to increase; approximately 5–6°C (9-11°F) prior to the lethal endpoint, fish began frantically swimming around the tank, presumably looking for an escape route. As fish began to lose equilibrium, their activity level decreased dramatically, and at about 0.3°C (0.54°F)before the lethal endpoint, most fish were completely incapacitated. Estimated upper limits of safe temperature (ULST) ranged from 28.7 to 31.1°C (83.7-88°F) and varied with acclimation temperature and measured endpoint. Upper limits of safe temperature (ULST) were determined by subtracting a safety factor of 5°C (9°F) from the lethal and critical thermal maxima data. Final thermal preference and thermal growth optima were nearly identical for fish at each acclimation temperature and ranged from 26.2 to 28.3°C (79.16-82.9°F). Critical thermal maxima (the point at which fish lost equilibrium) ranged from 33.7 (±0.3) to 36.1°C (±0.2) (92.7-97°F) and varied with acclimation temperature. Ziegeweid et al. (2008b) used data from laboratory experiments to examine the individual and interactive effects of salinity, temperature, and fish weight on the survival of young-of-year shortnose sturgeon. Survival in freshwater declined as temperature increased, but temperature tolerance increased with body size. The authors conclude that temperatures above 29°C (84.2°F) substantially reduce the probability of survival for young-of-year shortnose sturgeon. However, previous studies indicate that juvenile sturgeons achieve optimum growth at temperatures close to their upper thermal survival limits (Mayfield and Cech 2004; Allen et al. 2006; Ziegeweid et al. 2008a), suggesting that shortnose sturgeon may seek out a narrow temperature window to maximize somatic growth without substantially increasing maintenance metabolism. Ziegeweid (2006) examined thermal tolerances of young of the year shortnose sturgeon in the lab. The lowest temperatures at which mortality occurred ranged from 30.1 – 31.5°C (86.2-88.7°F) depending on fish size and test conditions. For shortnose sturgeon, dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

7.2.1.3 Thermal Tolerances – Atlantic sturgeon

Limited information on the thermal tolerances of Atlantic sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall *et al.* 2010). In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). These tests were carried out with fish reared at the US Fish and Wildlife Service's Northeast Fishery Center (Lamar, PA) and are progeny of Hudson River broodstock. Thus, it is reasonable to rely on results of this study when considering thermal tolerances of Atlantic sturgeon in the Hudson River.

Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.*. 2008 and Jenkins *et al.*. 1993); however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. For purposes of considering effects of thermal tolerances, shortnose sturgeon are a reasonable surrogate for Atlantic sturgeon given similar geographic distribution and known biological similarities.

7.2.1.4 Effect of Thermal Discharge on Shortnose and Atlantic Sturgeon

The lab studies discussed in Section 7.2.1.2 above, indicate that thermal preferences and thermal growth optima for shortnose sturgeon range from 26.2 to 28.3°C (79.2-83°F). This is consistent with field observations which correlate movements of shortnose sturgeon to thermal refuges when river temperatures are greater than 28°C (82.4°F) in the Altamaha River. Lab studies (see above; Ziegeweid et al. 2008a and 2008b) indicate that thermal maxima for shortnose sturgeon are 33.7 (±0.3) – 36.1(±0.1) (92.7-97°F), depending on endpoint (loss of equilibrium or death) and acclimation temperature (19.5 or 24.1°C). Upper limits of safe temperature were calculated to be 28.7 – 31.1°C (83.7-88°F). At temperatures 5-6°C (9-11°F) less than the lethal maximum, shortnose sturgeon are expected to begin demonstrating avoidance behavior and attempt to escape from heated waters; this behavior would be expected when the upper limits of safe temperature are exceeded. For purposes of this consultation, we will consider these threshold temperature values to also apply to Atlantic sturgeon.

We first consider the potential for sturgeon to be exposed to temperatures which would most likely result in mortality. To be conservative, we considered mortality to be likely at temperatures that are expected to result in loss of equilibrium (33.7±0.3 for fish acclimated to temperatures of 19.5°C and 36.1±0.2 for fish acclimated to temperatures of 24.1°C). As noted above, shortnose and Atlantic sturgeon in the Hudson River are most often found in areas where temperatures are approximately 24°C suggesting that use of temperatures for fish acclimated to temperatures of 24.1°C is reasonable.

The maximum observed temperature of the thermal discharge is approximately 35°C (95°F). Modeling has demonstrated that the surface area of the river affected by the Indian Point plume where water temperatures would exceed 32.22°C (90°F) would be limited to an area no greater than 75 acres. Information provided by Entergy and presented in the recent thermal model (Swanson et al. 2011) indicate that water temperatures will not exceed 32.2°C (90°F) in waters more than 5 meters (16.4 feet) from the surface. Because 32.22°C is below the temperature that would result in a loss of equilibrium, we do not expect loss of equilibrium or death to fish exposed to this temperature. Water depths in the area are approximately 18 meters (59 feet) meaning that there should be 13 meters of water column with water temperatures below 32.22°C. Given this information, it is unlikely that shortnose or Atlantic sturgeon remaining near the bottom of the river or even in the middle of the water column would be exposed to water temperatures of 33.7°C (92.7°F). Temperatures at or above 33.7°C (92.7°F) will occasionally be experienced at the surface of the river in areas closest to the discharge point. Shortnose and Atlantic sturgeon are known to move to deep cool water areas during the summer months in southern rivers. Laboratory studies using shortnose sturgeon (progeny from Savannah River broodstock) and Atlantic sturgeon (progeny from Hudson River broodstock) demonstrate that these species are able to identify and select between water quality conditions that significantly affect growth and metabolism, including temperature. Based on field observations and laboratory studies, we expect that sturgeon would actively avoid areas where temperatures are intolerable. Assuming that there is a gradient of temperatures decreasing with distance from the outfall (as illustrated in Swanson et al. 2011), we expect shortnose and Atlantic sturgeon to begin avoiding areas with temperatures greater than 28°C (82.4°F). We do not expect individuals to remain within the heated surface waters to swim towards the outfall and be exposed to temperatures which could result in mortality. As such, provided that conditions allow for sturgeon to detect changes in temperature (i.e., that there is a gradual gradient of temperatures decreasing with increasing distance from the outfall as reported in Swanson et al. 2011) and escape from the area prior to prolonged exposure to critical temperatures, it is extremely unlikely that any sturgeon would remain within the area where surface temperatures are elevated to 33.7°C (92.7°F) and be exposed to potentially lethal temperatures. This gradient of temperatures that decreases from the surface to the bottom is also expected to deter sturgeon from moving high enough up into the water column to encounter surface waters that have stressful or lethal temperatures. Tis risk is further reduced by the limited amount of time shortnose and Atlantic sturgeon spend near the surface, the small area where such high temperatures will be experienced and the gradient of warm temperatures extending from the outfall. Near the bottom where shortnose and Atlantic sturgeon most often occur, water temperatures are not likely to ever reach 33.7°C (92.7°F), creating no risk of exposure to temperatures likely to be lethal near the bottom of the river. It is important to note that this analysis is dependent on the assumption that exposure to increased temperatures will be gradual; that is, we do not anticipate that sturgeon would be exposed to rapid changes in water temperature. As noted in Ziegweid (2008a), heating rate is a factor in determining critical

Comment [A6]: Question to NRC/Entergy – in this context, please describe the characteristics of the discharge during (1) routine operations, (2)during times when a unit is shut down and restarted and (3) at times when generation is increasing. For example, is the discharge always at a steady flow and temperature or are there fluctuations? What is the time frame associated with these fluctuations (seconds, minutes, hours?) ? How quickly can temperatures change near the intakes? What documentation supports your answers?

maxima (loss of equilibrium and mortality). In order for there to be a loss of equilibrium or mortality a fish must be exposed to the heat source long enough for deep body temperatures to equal water temperatures. However, Ziegweid does not provide any indication of the length of time fish were exposed to critical temperatures before loss of equilibrium or mortality would occur. He does note, however, that larger fish will take longer to "heat up" than smaller fish.

We have also considered the potential for shortnose and Atlantic sturgeon to be exposed to water temperatures greater than 28°C (82.4°F). Available information from field observations (primarily in southern systems; however this may be related to the prevalence of temperatures greater than 28°C in those areas compared to the rarity of ambient temperatures greater than 28°C in northern rivers) and laboratory studies (using progeny of fish from southern and northern rivers) suggests that water temperatures of 28°C (82.4°F) or greater can be stressful for sturgeon and that shortnose and Atlantic sturgeon are likely to actively avoid areas with these temperatures. This temperature (28°C; (82.4°F)) is close to both the final thermal preference and thermal growth optimum temperatures that Ziegeweid et al. (2008) reported for juvenile shortnose sturgeon acclimated to 24.1 °C (75.4 °F), and thus is consistent with observations that optimum growth temperatures are often near the maximum temperatures fish can endure without experiencing physiological stress. Based on the available information, it is reasonable to anticipate that shortnose and Atlantic sturgeon will actively avoid areas with temperatures greater than 28°C.

In the summer months (June – September) ambient river temperatures can be high enough that temperature increases as small as 1-4°C (1.8-7.2°C) may cause water temperatures within the plume to be high enough to be avoided by shortnose and Atlantic sturgeon (greater than 28°C (82.4°F)). When ambient river temperatures are at or above 28°C (82.4°F), the area where temperatures are raised by more than 1.5°C (2.7°F) are expected to be limited to a surface area of up to 75 acres. Shortnose and Atlantic sturgeon exposure to the surface area where water temperature may be elevated above 28°C (82.4°F) due to the influence of the thermal plume is limited by their normal behavior as benthic-oriented fish, which results in limited occurrence near the water surface. Assuming that there is a gradient of water temperatures that decreases with increasing distance from the outfall and decreases with depth from the surface, any surfacing shortnose or Atlantic sturgeon are likely to detect the increase in water temperature and swim away from near surface waters with temperatures greater than 28°C (82.4°F). Reactions to this elevated temperature are expected to consist of swimming away from heated surface waters by traveling deeper in the water column or by swimming around bottom waters heated by the plume.

Under no conditions did interpolated temperatures in Entergy's modeled results exceed 28°C (82°F) in the deep reaches of the river channel (Swanson 2011 a) where shortnose sturgeon are most likely to occur. Swanson also examined other sources of available bottom water temperature data for the Indian Point area. Based upon examination of the 1997 through 2010 long river survey water temperature data from the near-bottom stations near Indian Point, 28°C (82.4°F) was exceeded for just 56 of 1,877 observations or 2.98% during this 14-year period (readings measured weekly from March through November). These already low incidences of observed near-bottom water temperatures above 28°C (82.4°F) would be even lower when viewed in the context of an entire year instead of the nine months sampled due to the cold water period not sampled from December through February (i.e., 2.24% for the Indian Point region).

Comment [A7]: Question for NRC – What is it about the model that results in findings that bottom waters never exceeded 28C while this information indicates that water temperatures at the bottom can be higher than 28C ?

The available information on the thermal plume indicates that water temperature at the bottom of the river will be elevated to above 28°C only rarely (approximately 2.24% of the time). We expect that sturgeon will avoid bottom waters where temperatures are greater than 28°C. Sturgeon in the action area are likely to be foraging, resting or migrating. Disruptions to these behaviors will be limited to moving away from the area with stressful temperatures. Given the small area that may have temperatures elevated above 28°C (82.4°F) it is extremely unlikely that these minor changes in behavior will preclude shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

Given that shortnose and Atlantic sturgeon are known to actively seek out cooler waters when temperatures rise to 28°C (82.4°F), any shortnose sturgeon encountering bottom waters with temperatures above 28°C (82.4°F) area are likely to avoid it. Reactions to this elevated temperature are expected to be limited to swimming away from the plume by swimming around it. Given the extremely small percentage of the estuary that may have temperatures elevated above 28°C (82.4°F) and the limited spatial and temporal extent of any elevations of bottom water temperatures above 28°C (82.4°F), it is extremely unlikely that these minor changes in behavior will preclude any shortnose or Atlantic sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

We have considered whether avoidance of the thermal plume would affect the likelihood of impingement at the intakes. The intakes are located upstream of the discharge canal. During ebb tides, the thermal plume is largely directed downstream; at flood tide the area of stressful temperatures may overlap the intake area. The thermal plume could influence the likelihood of impingement if sturgeon were more likely to be present near the intakes because of avoidance behavior related to the thermal plume or if sturgeon present near the intakes were suddenly overcome by discharges of warm water and lost equilibrium. Based on the available information, neither one of these scenarios seems likely. Based on illustrations of the thermal plume (see Swanson et al. 2011a and 2011b) there do not appear to be any conditions during which sturgeon would move to the intake area to seek refuge from heated waters. Sturgeon are most likely to be present in the deep channel. Considering the cross section of the river immediately adjacent to the intakes, there do not appear to be any conditions under which sturgeon would be displaced from the deepwater areas by thermal conditions and would move towards the eastern shoreline where the intakes are located. Therefore, it is not reasonable to anticipate that sturgeon that move to avoid the thermal plume would be more likely to be present near the intakes as there are adjacent deepwater areas near by as well as the area on the western side of the river that is largely unaffected by the plume. The available information on the thermal discharge indicates that there is a gradual gradient of warmed water originating from the discharge canal. Given the distance of the discharge canal from the intakes (over 200 meters (700 feet) to IP3 and over 400 meters (1,400 feet) to IP2), and our understanding of the discharge it is unlikely that water temperature changes in the river near the intake would be rapid enough to prevent sturgeon from avoiding water at temperatures that would result in impairment and a resulting increased likelihood of impingement. We also considered whether swimming to avoid the thermal plume would make sturgeon tired and less able to avoid impingement. However, because of the gradual gradient of water temperatures and the size of the plume, sturgeon will not need to swim long distances to avoid heated water. As noted above, we do not expect any energy expenditure to have any detectable effect on the physiology of any individuals. Therefore, it is unlikely that swimming to avoid the thermal plume would result in exhaustion and decreased ability to avoid the intakes.

Water temperature and dissolved oxygen levels are related, with warmer water generally holding less dissolved oxygen. As such, we considered the potential for the discharge of heated effluent to affect dissolved oxygen in the action area. Entergy provided an assessment of dissolved oxygen conditions in the vicinity of the thermal plume and nearby downstream areas. Swanson examined dissolved oxygen concentrations observed among 14 recent years (1997 through 2010) of water quality samples taken 0.3 m (1 ft) above the river bottom weekly during the Utilities Fall Shoals surveys in the Indian Point region of the Hudson River from March through November of each year. Only 17 (0.91%) dissolved oxygen concentrations below 5 mg/l were observed in the Indian Point region during this 14-year period consisting of 1,877 readings, and the lowest dissolved oxygen concentration of 3.4 mg/l occurred just once, while the remaining 16 values were between 4.4 mg/l and 4.9 mg/l. Although I/FS survey water quality sampling did not occur in the Indian Point region during the winter period from December through February of each year due to river ice conditions, it is unlikely that dissolved oxygen concentrations below 5 mg/l would be observed then due to the high oxygen saturation of the cold water in the winter. The Hudson River region south of the Indian Point region had 501 dissolved oxygen concentrations below 5 mg/l (6.33% of 7,918 total observations) in the near bottom waters, seven times more frequently than the Indian Point region. Based on this information the discharge of heated effluent appears to have no discernible effect on dissolved oxygen levels in the area. As the thermal plume is not contributing to reductions in dissolved oxygen levels, it will not cause changes in dissolved oxygen levels that could affect any shortnose or Atlantic sturgeon.

7.2.1.5 Effect on Shortnose and Atlantic Sturgeon Prey

Shortnose and Atlantic sturgeon feed primarily on benthic invertebrates; these prey species are found on the bottom. As explained above, the IP thermal plume is largely a surface plume with elevated temperatures near the bottom limited to short duration and a geographic area limited to the area close to the discharge point. No analysis specific to effects of the thermal plume on the macroinvertebrate community has been conducted. However, given what is known about the plume (i.e., that it is largely a surface plume and has limited effects on water temperatures at or near the bottom) and the areas where shortnose sturgeon forage items are found (i.e., on the bottom), it is unlikely that potential sturgeon forage items would be exposed to the effects of the thermal plume. If the thermal plume is affecting benthic invertebrates, the most likely effect would be to limit their distribution to areas where bottom water temperatures are not affected by the thermal plume. Considering that shortnose and Atlantic sturgeon are also likely to be excluded from areas where the thermal plume influences bottom water temperatures and given that those areas are small, foraging sturgeon are not likely to be affected by any limits on the distribution of benthic invertebrates caused by the thermal plume's limited influence on bottom waters. Thus, based on this analysis, it appears that the prey of shortnose or Atlantic sturgeon, would be impacted insignificantly, if at all, by the thermal discharge from IP.

7.2.2 Potential Discharge of Radionuclides to the Hudson River

Comment [A8]: Question to NRC and Entergy – It is our understanding you will be undertaking new fish sampling in Haverstraw Bay in 2013. Will you be applying for a modification to your ESA Section 10 permit for this work? If not, why not?

Environmental monitoring and surveillance for radionuclides have been conducted at IP2 and IP3 since 1958, four years before the startup of IP1. The preoperational program was designed and implemented to determine the background radioactivity and to measure the variations in activity levels from natural and other sources in the vicinity, as well as fallout from nuclear weapons tests. The preoperational radiological data include both natural and manmade sources of environmental radioactivity. These background environmental data permit the detection and assessment of current levels of environmental activity attributable to plant operations.

The annual REMP is carried out by Entergy to monitor and document radiological impacts to the environment and the public around the IP2 and IP3 site and compare these to NRC standards. Radionuclides monitored include tritium (^{3}H), strontium-90 (^{90}Sr), nickel-63, and cesium-137. Entergy summarizes the results of its REMP in an Annual Radiological Environmental Operating Report. The objectives of the IP2 and IP3 REMPs are the following: (1) to enable the identification and quantification of changes in the radioactivity of the area; and, (2) to measure radionuclide concentrations in the environment attributable to operations of the IP2 and IP3 site (NRC 2010).

The REMP at IP2 and IP3 directs Entergy to sample environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The REMP designates sampling locations for the collection of environmental media for analysis. These sampling locations are divided into indicator and control locations. Indicator locations are established near the site, where the presence of radioactivity of plant origin is most likely to be detected. Control locations are established farther away (and upwind/upstream, where applicable) from the site, where the level would not generally be affected by plant discharges or effluents. The use of indicator and control locations enables the identification of potential sources of detected radioactivity as either background or from plant operations. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents. The REMP is used to measure the direct radiation and the airborne and waterborne pathway activity in the vicinity of the IP2 and IP3 site. Direct radiation pathways include radiation from buildings and plant structures, airborne material that may be released from the plant, or from cosmic radiation, fallout, and the naturally occurring radioactive materials in soil, air, and water. The liquid waste processing system at IP2 and IP3 collects, holds, treats, processes, and monitors all liquid radioactive wastes for reuse or disposal. During normal plant operations the system receives input from numerous sources, such as equipment drains and leak lines, chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak lines, and floor drains. After it is determined that the amount of radioactivity in the wastewater is diminished to acceptable levels, the water is released into the Hudson River.

Entergy has also identified the migration of tritium to the Hudson River through groundwater pathways. In 2005, Entergy discovered a spent fuel pool water leak to groundwater while installing a new crane to facilitate transfer of Unit 2 spent fuel to dry cask storage. This leak was determined to have generated a groundwater plume of tritium (^{3}H). During efforts to track the ^{3}H plume, ^{90}Sr was discovered in a downgradient portion of the plume and traced back to a leak in the Unit 1 spent fuel pool (Skinner and Sinnott 2009). Because site groundwater flows to the Hudson River, the 2006 Radiological Environmental Monitoring Program (REMP) conducted by Entergy was modified to include ^{90}Sr as an analyte in fish samples. ^{90}Sr was detected in 4 of 10 samples of fish taken from the river in the vicinity of the Indian Point facility, and in three of five samples from an upstream reference location near the Roseton Generating Station in Newburgh, NY. The tissues analyzed were composites of edible flesh from fish representing several species. Entergy concluded that the ^{90}Sr levels were low and may be indistinguishable from background levels from fallout from nuclear weapons testing in the 1950's and 1960's (Entergy 2007). The New York State Departments of Health (NYSDOH) and NYSDEC concurred with Entergy's assessment. However, the NYSDEC and NYSDOH were concerned that the home ranges of several sampled species, and all striped bass, may overlap at the two sampling sites (Skinner and Sinnott 2009). In order to assure independence of sampling sites, the NY agencies initiated a one-time enhanced radiological surveillance for 2007 (results presented in Skinner and Sinnott 2009). The objectives of the enhanced radiological monitoring effort were to: gain information about the levels, impacts, and possible ^{90}Sr sources at the reference locations and the indicator station; determine if significant spatial differences in ^{90}Sr concentrations were present; to assess whether or not ^{90}Sr concentrations in the bones and flesh of fish signify heightened risk either to aquatic life in the Hudson River; and, provide information for an independent assessment of potential public health impacts.

The one-time design modifications for the 2007 effort included: the addition of carp (*Cyprinus carpio*) – a benthic feeder – to the target species list; adding ^{90}Sr to the list of radionuclide analytes; analysis of fish bone or crab carapace; and , sampling fish at a third location, the Catskill Region between river miles 107 and 125. The NY agencies stated that this upstream location assures appropriate separation of fish populations that are resident to the river, and, consequently, assures isolation of resident fish populations from the potential influence of discharges from the Indian Point facility.

The study concluded that there were no apparent excursions above criteria for the protection of biota based on the radionuclide data available. The levels of radionuclides, including ^{90}Sr, were two to five orders of magnitude lower than criteria established by the US Department of Energy (USDOE 2002) for the protection of aquatic animals and freshwater ecosystems. Also, the study concluded that there were no spatial differences in concentrations of ^{90}Sr and ^{224}Ra in resident fish from the three locations sampled in the lower Hudson River (i.e., Indian Point facility, and the reference sites at the Roseton Generating Station and at Catskill). In contrast, ^{40}K levels were somewhat greater in the vicinity of Roseton Generating Station, but the differing concentrations have no known significance.

Detailed information on the radiological investigations, including groundwater, is available in the 2006-2009 REMPs. NRC indicates in the FSEIS that this multi-year period provides a representative data set that covers a broad range of activities that occur at IP2 and IP3 such as, refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities, and that effects during an extended operating period would be consistent with these sampling periods. In the FSEIS, NRC reports that tritium releases in total (groundwater as well as routine liquid effluent) represent less than 0.001% of the Federal dose limits for radioactive effluents from the site. In addition to monitoring potential effects to human health from exposure to radiation, Entergy conducts inspections of radionuclides in the environment, including fish and river sediments.

NRC has reported to NMFS that NRC has reviewed all of the available information on radionuclides and has identified no unusual trends or significant radiological impacts to the environment, including Hudson River water, river sediments and fish tissues, due to operation of the Indian Point facility. In the FSEIS, NRC states that no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations. NRC also summarizes a 2007 NYSDEC report which concludes that strontium-90 levels in fish near the site (18.8 pCi/kg (0.69 Bq/kg)) are no higher than in those fish collected from background locations across New York State.

As explained above, additional information on potential impacts of radionuclides potentially originating from the Indian Point facility on aquatic organisms in the Hudson River is available in a recent report prepared by NYDEC (Skinner and Sinnott 2009). Neither the Skinner and Sinnott report or any of the REMPs identified radionuclide levels attributable to operation of the Indian Point facility that are at levels that are thought to negatively impact fish. It is important to note that no shortnose or Atlantic sturgeon have been tested to determine levels of radionuclides; however, as other species that have been sampled that are similarly mobile through the Hudson River have not indicated that they have radionuclide levels of concern and because expert review (NRC and NYDEC) of environmental indicators (Hudson River water, sediments, aquatic organisms) also indicates that radionuclides originating from the Hudson River, are not at levels of concern. Based on this information, while shortnose and Atlantic sturgeon may be exposed to radionuclides originating from Indian Point, as well as other sources, any exposure is not likely to be at levels that would affect the health or fitness of any individual shortnose or Atlantic sturgeon. Thus, NMFS considers the effects to shortnose and Atlantic sturgeon from radionuclides to be insignificant and discountable.

7.2.3 Other Pollutants Discharged from IP2 and IP3

The 1987 SPDES permit contains effluent limits related to an on-site sewage treatment plant, as well as cooling water discharges. The on-site sewage treatment plant is no longer operational and sanitary waste from Indian Point is now routed to the community wastewater treatment plant. Therefore, no sanitary waste discharges at the Indian Point outfalls will occur during the extended operating period. Other than the pollutants associated with sanitary wastes, pollutants limited by the 1987 SPDES permit include: total residual chlorine (TRC), lithium hydroxide, boron, pH, total suspended solids (TSS), and, oil and grease.

NMFS has no information on the actual levels of these pollutants discharged in the past. NMFS assumes, for the purposes of this analysis, that discharges from Indian Point will be in compliance with the pollutant limits included in the 1987 SPDES permit. The effect of discharges in compliance with these limits on shortnose sturgeon is discussed below.

7.2.3.1 Total Residual Chlorine

TRC is limited at a maximum daily average of 0.2mg/l. This level of chlorine is measured in the plant, prior to dilution in the Hudson River. Once the waste stream mixes with the Hudson River, concentrations of TRC will be a maximum of 0.019 mg/l (for one hour) and 0.011mg/l (indefinitely).

To date, the effects of TRC on shortnose sturgeon have not been studied; however, there have been a number of studies that have examined the effects of levels of TRC on various fish species (Post 1987; Buckley 1976), including a recent study done on the white sturgeon (Campbell and Davidson 2007). Campbell and Davidson (2007) found that at concentrations of 0.034-0.042 mg/l of chlorine over four days, 50% of the test population, which consisted of 30 day old and 160 day old early life stage and juvenile sturgeon, died (i.e., 96 hour LC50). Similarly, adverse effects to rainbow trout (e.g., reductions of hemoglobin and hemocrit levels indicative of anemia) were found to occur at TRC levels of approximately 0.03 -0.04 mg/L (Buckley 1976; Black and McCarthy 1990). In a study conducted by Dwyer et al. (2000a), researchers compared toxicity test results for a range of species tested, including shortnose and Atlantic sturgeon. While TRC was not one of the compounds tested, the authors concluded that toxicity test results for rainbow trout were a good surrogate for effects to listed fish species, including shortnose sturgeon. As such, while recognizing that these conclusions are based on a limited number of chemical exposures, if rainbow trout can be considered a reasonable surrogate for toxicity testing for shortnose and Atlantic sturgeon, and TRC levels of 0.03-0.04mg/l have been shown to cause adverse affects to rainbow trout, it is reasonable to conclude that shortnose sturgeon would also experience adverse effects if exposed to TRC levels of 0.03-0.04mg/l. The concentration of TRC authorized by the SPDES permit (0.011mg/l in the river) is below the levels shown to adversely affect fish. As such, NMFS anticipates that any effects to shortnose and Atlantic sturgeon from exposure to TRC at concentrations authorized by the SPDES permit would be insignificant and discountable.

7.2.3.2 Lithium hydroxide

The 1987 SPDES permit authorizes the discharge of lithium hydroxide at a daily maximum concentration of 0.01mg/l. Limited information is available on the toxicity of lithium hydroxide to aquatic species. The no effect concentration level for fish is reported at 13mg/l as determined by exposure of fathead minnows; no effect concentration levels for Daphnia magna are reported at 11mg/l (Long et al. 1997). While no studies have examined the effects of lithium exposure to shortnose sturgeon, as the levels of lithium authorized by the SPDES permit are lower than the levels shown to have no effects to fathead minnows, which are typically used as a surrogate species for other fish in toxicity testing, we anticipate that any effects to shortnose or Atlantic sturgeon from exposure to boron at concentrations authorized by the SPDES permit would be insignificant and discountable.

7.2.3.3 Boron

The 1987 SPDES permit authorizes the discharge of boron at monthly average concentrations of 1.0mg/l. Chronic toxicity studies with *Daphnia magna* indicate no effect concentration (NOEC) levels ranging between 6 and 10 mg boron/litre (IPCS 1998). A 28-day laboratory study consisting of six trophic stages yielded a NOEC of 2.5 mg boron/litre. Acute tests with several fish species yielded toxicity values ranging from about 10 to nearly 300 mg boron/litre. Rainbow trout (*Oncorhynchus mykiss*) and zebra fish (*Brachydanio rerio*) were the most sensitive, providing values around 10 mg boron/liter (IPCS 1998). While no studies have examined the effects of boron exposure to shortnose or Atlantic sturgeon, as the levels of boron authorized by the SPDES permit are lower than the levels shown to have no effects to a variety of fish species, we anticipate that any effects to shortnose and Atlantic sturgeon from exposure to boron at concentrations authorized by the SPDES permit would be insignificant and discountable.

7.2.3.4 pH
The permit requires that the discharge maintain a pH of 6.0 – 9.0. This pH is within the normal range of pH for river water. As such, any change in the pH of the receiving water due to the discharge from Indian Point is not expected to deviate significantly from the receiving waters pH and will remain within the normal range for river water that is known to be harmless to aquatic life. Therefore, any effects to shortnose and Atlantic sturgeon will be discountable.

7.2.3.5 Total Suspended Solids
The 1987 SPDES permit limits the discharge of TSS to a daily maximum of 50mg/l and a monthly average of 30mg/L. TSS can affect aquatic life directly by killing them or reducing growth rate or resistance to disease, by preventing the successful development of fish eggs and larvae, by modifying natural movements and migration, and by reducing the abundance of available food (EPA 1976). These effects are caused by TSS decreasing light penetration and by burial of the benthos. Eggs and larvae are most vulnerable to increases in solids. Due to the distance from the spawning site, neither shortnose or Atlantic sturgeon eggs or larvae are likely to occur in the vicinity of the discharge.

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580mg/L to 700,000mg/L depending on species. Sublethal effects have been observed at substantially lower turbidity levels. For example, prey consumption was significantly lower for striped bass larvae tested at concentrations of 200 and 500 mg/L compared to larvae exposed to 0 and 75 mg/L (Breitburg 1988 in Burton 1993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993). While there have been no directed studies on the effects of TSS on shortnose or Atlantic sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water and Dadswell (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass. Given that Atlantic sturgeon occur in similar habitats to shortnose sturgeon, we expect Atlantic sturgeon to have similar tolerances to suspended sediments and turbidity as shortnose sturgeon.

No adverse effects to juvenile or adult fish have been documented at levels at or below 50mg/L (above the highest level authorized by this permit). Based on this information, it is likely that the discharge of TSS in the concentrations authorized by the permit will have an insignificant effect on shortnose and Atlantic sturgeon.

7.2.3.6 Oil and Grease

High concentrations of petroleum products such as oil and grease can be toxic to aquatic life, including shortnose sturgeon. EPA (1976) indicates that lethal levels of gasoline for finfish are 91mg/L and for waste oil are 1700mg/L. No information is available on the toxic levels of petroleum products on shortnose sturgeon specifically. The limits in the SPDES permit (15mg/L monthly average) is well below the limits demonstrated to cause effects to fish. In addition, as the permit prohibits the discharge of levels of oil and grease at levels that are visible, levels are not likely to reach those where there is a risk of coating. As such, the effect of any exposure of shortnose and Atlantic sturgeon to oil and grease discharged at levels in compliance with the SPDES permit will be insignificant and discountable.

7.2.3.7 Other Criteria and Requirements of the SPDES Permit

The permit also contains criteria for the thermal plume. Effects of the thermal discharge are considered above. The 1987 SPDES permit also directs Entergy to comply with the biological sampling requirements of the HRSA. These include sampling surveys conducted throughout the Hudson River. These surveys result in the capture of shortnose and Atlantic sturgeon; however, capture and handling of shortnose and Atlantic sturgeon during these studies is authorized by NMFS through the ESA Section 10 scientific research permit discussed above (currently permit #17095, available at: https://apps.nmfs.noaa.gov/preview/applicationpreview.cfm?ProjectID=17095&view=01000000000000). The permit authorizes the take of 82 shortnose sturgeon and 82 Atlantic sturgeon annually. These fish will be captured in trawls and will be tagged (PIT and dart), measured, weighed and have tissue samples taken. The permit also authorizes the lethal collection of 40 shortnose sturgeon eggs/larvae and 40 Atlantic sturgeon eggs/larvae annually. These early life stages will be collected during ichthyoplankton sampling. The permit is valid from January 20, 2012 until August 28, 2017. All sturgeon captured during the trawl surveys are expected to be returned to the river alive. No lethal or sublethal effects of trawling are anticipated. The only lethal take authorized by the Section 10 permit is for the 40 eggs or larvae captured during ichthyoplankton sampling. The ESA Section 7 consultation completed on the issuance of this permit determined that the action was not likely to jeopardize the continued existence of shortnose sturgeon or any DPS of Atlantic sturgeon (available at: http://www.nmfs.noaa.gov/pr/consultation/opinions.htm). Because effects to listed species from these studies have already been considered, these studies will not be considered further in this Opinion.

7.3 Non-Routine and Accidental Events

By their nature, non-routine and accidental events that may affect the marine environment are unpredictable and typically unexpected. In the FSEIS, NRC considers design-basis accidents (DBAs); these are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. NRC states that "a number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility" (NRC FSEIS 2011). NRC states that the environmental impacts of these DBAs will be “small” (i.e., insignificant), because the plant is designed to withstand these types of accidents including during the extended operating period.

NRC also states that the risk of severe accidents initiated by internal events, natural disasters or terrorist events is small. As noted by Thompson (2006) in a report regarding the risks of spent-fuel pool storage at nuclear power plants in the U.S., the available information does not allow a statistically valid estimate of the probability of an attack-induced spent-fuel-pool fire. However, Thompson states that “prudent judgment” indicates that a probability of at least one per century within the U.S. is a reasonable assumption. There have been very few instances of accidents or natural disasters that have affected nuclear facilities and none at IP2 or IP3 that have led to any impacts to the Hudson River. While the experience at Fukishima in Japan provides evidence that natural disaster induced problems at nuclear facilities can be severe and may have significant consequences to the environment, the risk of non-routine and accidental events at Indian Point that would affect the riverine environment, and subsequently affect shortnose and Atlantic sturgeon, is extremely low. Because of this, effects to listed species are discountable. We expect that in the unlikely event of any accident or disaster that affects the riverine environment, reinitiation of consultation, or an emergency consultation, would be necessary.

7.4 Effects of Operation in light of Anticipated Future Climate Change

In the future, global climate change is expected to continue and may impact listed species and their habitat in the action area. The period considered for the continued operation of IP2 is now through 2033 and for IP3 is now through 2035.

In section 6.0 above we considered effects of global climate change on shortnose and Atlantic sturgeon. It is possible that there will be effects to sturgeon from climate change over the time that IP2 and IP3 continue to operate. As explained above, based on currently available information and predicted habitat changes, these effects are most likely to be changes in distribution and timing of seasonal migrations of sturgeon throughout the Hudson River including the action area. However, because we expect only a small increase in water temperature (1°C) and a small change in the location of the salt wedge (shifting further upstream from the action area), there are not likely to be major shifts in abundance, distribution or seasonal use of the action area by Atlantic sturgeon or shortnose sturgeon.

The greatest potential for climate change to impact our assessment would be if (1) ambient water temperatures increased enough such that a larger portion of the thermal plume had temperatures that were stressful for listed species or their prey or if (2) the status, distribution and abundance of listed species or their prey changed significantly in the action area. Given the small predicted increase in ambient water temperatures in the action area during the time period considered (1°C), it is not likely that over the remainder of the operating period that any water temperature changes would be significant enough to affect the conclusions reached by us in this consultation. If new information on the effects of climate change becomes available then reinitiation of this consultation may be necessary.

8.0 CUMULATIVE EFFECTS

Cumulative effects, as defined in 50 CFR 402.02, are those effects of future State or private activities, not involving Federal activities, which are reasonably certain to occur within the action area. Future Federal actions are not considered in the definition of "cumulative effects." It is important to note that the definition of "cumulative effects" in the section 7 regulations is not the same as the NEPA definition of cumulative effects. However, the factors discussed in the Cumulative Effects section of NRC's FSEIS - continued withdrawal of water to support fossil fuel electrical generation or water for human use; the presence of invasive or nuisance species; fishing pressure; habitat loss; changes to water and sediment quality; and, climate change are largely consistent with the cumulative effects we consider here.

Activities reasonably certain to occur in the action area and that are carried out or regulated by the State of New York and that may affect shortnose and Atlantic sturgeon include the authorization of state fisheries and the regulation of point and non-point source pollution through the National Pollutant Discharge Elimination System. We are not aware of any local or private actions that are reasonably certain to occur in the action area that may affect listed species.

While there may be other in-water construction or coastal development within the action area, all of these activities are likely to need a permit or authorization from the US Army Corps of Engineers and would therefore, be subject to section 7 consultation.

State Water Fisheries - Future recreational and commercial fishing activities in state waters may take shortnose and Atlantic sturgeon. In the past, it was estimated that up to 100 shortnose sturgeon were captured in shad fisheries in the Hudson River each year, with an unknown mortality rate. Atlantic sturgeon were also incidentally captured in NY state shad fisheries. In 2009, NY State closed the shad fishery indefinitely. That state action is considered to benefit both sturgeon species. Should the shad fishery reopen, shortnose and Atlantic sturgeon would be exposed to the risk of interactions with this fishery. However, NMFS has no indication that reopening the fishery is reasonably certain to occur.

Information on interactions with shortnose and Atlantic sturgeon for other fisheries operating in the action area is not available, and it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Status of the Species/Environmental Baseline section. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the status of the species/environmental baseline section.

State PDES Permits – The State of New York has been delegated authority to issue NPDES permits by the EPA. These permits authorize the discharge of pollutants in the action area. Some of the facilities that operate pursuant to these permits are included in the Environmental Baseline. Other permitees include municipalities for sewage treatment plants and other industrial users. The states will continue to authorize the discharge of pollutants through the SPDES permits. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the status of the species/environmental baseline section.

9.0 INTEGRATION AND SYNTHESIS OF EFFECTS

We have estimated that the continued operation of IP2 and IP3 and continued withdrawal of water through the IP1 intake, pursuant to the existing operating licenses and through the proposed extended license period (now through September 2033 and now through December 2035, respectively) will result in the impingement and mortality of 562 shortnose sturgeon and 219 juvenile New York Bight DPS Atlantic sturgeon. As explained in the "Effects of the Action" section, all other effects to shortnose and Atlantic sturgeon, including to their prey and from the discharge of heat, will be insignificant or discountable. No entrainment of shortnose or Atlantic sturgeon is anticipated.

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of any listed species. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Below, for the listed species that may be affected by the proposed action, NMFS summarizes the status of the species and considers whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of that species, as those terms are defined for purposes of the federal Endangered Species Act.

9.1 Shortnose Sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

The Hudson River population of shortnose sturgeon is the largest in the United States. Historical estimates of the size of the population are not available as historic records of sturgeon in the river did not discriminate between Atlantic and shortnose sturgeon. Population estimates made by

Dovel et al. (1992) based on studies from 1975-1980 indicated a population of 13,844 adults. Bain et al. (1998) studied shortnose sturgeon in the river from 1993-1997 and calculated an adult population size of 56,708 with a 95% confidence interval ranging from 50,862 to 64,072 adults. Bain determined that based on sampling effort and methodology his estimate is directly comparable to the population estimate made by Dovel et al. Bain concludes that the population of shortnose sturgeon in the Hudson River in the 1990s was 4 times larger than in the late 1970s. Bain states that as his estimate is directly comparable to the estimate made by Dovel, this increase is a “confident measure of the change in population size.” Bain concludes that the Hudson River population is large, healthy and particular in habitat use and migratory behavior. Woodland and Secor (2007) conducted studies to determine the cause of the increase in population size. Woodland and Secor captured 554 shortnose sturgeon in the Hudson River and made age estimates of these fish. They then hindcast year class strengths and corrected for gear selectivity and cumulative mortality. The results of this study indicated that there was a period of high recruitment (31,000 – 52,000 yearlings) in the period 1986-1992 which was preceded and succeeded by 5 years of lower recruitment (6,000 – 17,500 yearlings/year). Woodland and Secor reports that there was a 10-fold recruitment variability (as measured by the number of yearlings produced) over the 20-year period from the late 1970s to late 1990s and that this pattern is expected in a species, such as shortnose sturgeon, with periodic life history characterized by delayed maturation, high fecundity and iteroparous spawning, as well as when there is variability in interannual hydrological conditions. Woodland and Secor examined environmental conditions throughout this 20-year period and determined that years in which water temperatures drop quickly in the fall and flow increases rapidly in the fall (particularly October), are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults.

The Hudson River population of shortnose sturgeon has exhibited tremendous growth in the 20-year period between the late 1970s and late 1990s. Woodland and Secor conclude that this is a robust population with no gaps in age structure. Lower recruitment that followed the 1986-1992 period is coincident with record high abundance suggesting that the population may be reaching carrying capacity. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, add uncertainty to any determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is at best stable, with gains in populations such as the Hudson, Delaware and Kennebec offsetting the continued decline of southern river populations, and at worst declining.

As described in the Status of the Species/Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the action area are affected by impingement at water intakes, habitat alteration, bycatch in commercial and recreational fisheries, water quality and in-water construction activities. It is difficult to quantify the number of shortnose sturgeon that may be killed in the Hudson River each year due to anthropogenic sources. Through reporting requirements implemented under Section 7 and Section 10 of the ESA, for specific actions NMFS obtains some information on the number of incidental and directed takes of shortnose sturgeon each year. Typically, scientific research results in the capture and collection of less than 100 shortnose sturgeon in the Hudson River each year, with little if any mortality. NMFS has no reports of interactions or mortalities of shortnose sturgeon in the Hudson River resulting from dredging or other in-water construction activities. NMFS also has no quantifiable information on the effects of habitat alteration or water quality; in general, water quality has improved in the Hudson River since the 1970s when the CWA was implemented. NMFS also has anecdotal evidence that shortnose sturgeon are expanding their range in the Hudson River and fully utilizing the river from the Manhattan area upstream to the Troy Dam, which suggests that the movement and distribution of shortnose sturgeon in the river is not limited by habitat or water quality impairments. Impingement at the Roseton and Danskammer plants is regularly reported to NMFS. Since reporting requirements were implemented in 2000, less than the exempted number of takes (6 total for the two facilities) have occurred each year. We also anticipate the mortality of two shortnose sturgeon over the next five years as a result of impacts of the replacement of the Tappan Zee Bridge. Despite these ongoing threats, there is evidence that the Hudson River population of shortnose sturgeon experienced tremendous growth between the 1970s and 1990s and that the population is now stable at high numbers. Shortnose sturgeon in the Hudson River continue to experience anthropogenic and natural sources of mortality. However, NMFS is not aware of any future actions that are reasonably certain to occur that are individually or cumulatively likely to change this trend or reduce the stability of the Hudson River population. Also, as discussed above, NMFS does not expect shortnose sturgeon to experience any new effects associated with climate change during the 23-year duration of the proposed action. As such, NMFS expects that numbers of shortnose sturgeon in the action area will continue to be stable at high levels over the 23-year duration of the proposed action.

We have estimated that the proposed continued operation of IP2 and IP3 through the duration of the existing operating license and the proposed extended operating licenses (i.e., through September 29, 2033 for IP2 and December 12, 2035 for IP3) will result in the impingement of an average of 20 shortnose sturgeon per year, for a total of 444 shortnose sturgeon impinged, all of which may die as a result of their impingement. This number represents a very small percentage of the shortnose sturgeon population in the Hudson River, which is believed to be stable at high numbers, and an even smaller percentage of the total population of shortnose sturgeon rangewide. The best available population estimates indicate that there are approximately 56,708 (95% CI=50,862 to 64,072) adult shortnose sturgeon in the Hudson River and an unknown number of juveniles (Bain 2000). While the death of up to 444 shortnose sturgeon over the next 23 years will reduce the number of shortnose sturgeon in the population compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population or its stable trend. This is because this loss represents a very small percentage of the population (less than 0.8%, just considering the number of adults). The impact of this loss is even less when considered on an annual basis. The annual loss represents approximately 0.2% of the Hudson River shortnose sturgeon population. Additionally, it is important to note that this is not a new source of mortality. The Hudson River population has exhibited tremendous growth during the period of time that IP2 and IP3 have been operational; we do not expect the rate of impingement to change in the future, therefore, it is reasonable to expect that the continued operation of IP2 and IP3 would not preclude maintenance of the population's stable trend.

Reproductive potential of the Hudson population is not expected to be affected in any other way other than through a reduction in numbers of individuals. A reduction in the number of shortnose sturgeon in the Hudson River would have the effect of reducing the amount of potential reproduction in this system as the fish killed would have no potential for future reproduction. However, it is estimated that on average, approximately 1/3 of adult females spawn in a particular year and approximately ½ of males spawn in a particular year. Given that the best available estimates indicate that there are more than 56,000 adult shortnose sturgeon in the Hudson River, it is reasonable to expect that there are at least 20,000 adults spawning in a particular year. It is unlikely that the loss of 20 shortnose sturgeon per year over a 23-year period would affect the success of spawning in any year. Additionally, this small reduction in potential spawners is expected to result in a small reduction in the number of eggs laid or larvae produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individuals that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be very small and would not change the stable trend of this population. Additionally, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

The proposed action is not likely to reduce distribution because the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Hudson River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Additionally, as the number of shortnose sturgeon likely to be killed as a result of the proposed action is less than 0.80% of the Hudson River population, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species can have an appreciable effect on the likelihood of survival and recovery of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity (see status of the species/environmental baseline section above), and there are thousands of shortnose sturgeon spawning each year.

Based on the information provided above, the death of up to 562 shortnose sturgeon over a 23-year period (i.e., from now through December 2035) resulting from the proposed continued operation of IP2 and IP3 will not appreciably reduce the likelihood of survival of this species (i.e., the likelihood that the species will continue to exist in the future while retaining the potential for recovery) because, (1) it will not cause so many mortalities that the population will decrease; (2) the population trend of shortnose sturgeon in the Hudson River is stable at high levels; (3) the death of 24 shortnose sturgeon per year represents an extremely small percentage of the number of shortnose sturgeon in the Hudson River and an even smaller percentage of the species as a whole; (4) the loss of these shortnose sturgeon is likely to have such a small effect on reproductive output of the Hudson River population of shortnose sturgeon or the species as a whole that the loss of these shortnose sturgeon will not change the status or trends of the Hudson River population or the species as a whole; and, (5) the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area (related to movements around the thermal plume) and no effect on the distribution of the species throughout its range.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that shortnose sturgeon can rebuild to a point where shortnose sturgeon are no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for shortnose sturgeon was published in 1998 pursuant to Section 4(f) of the ESA. The Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely. However, the plan states that the minimum population size for each population has not yet been determined. The Recovery Outline contains three major tasks, (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the Hudson River population of shortnose sturgeon in a way that would affect the species likelihood of recovery.

The Hudson River population of shortnose sturgeon has experienced an increasing trend and is currently stable at high levels. This action will not change the status or trend of the Hudson River population of shortnose sturgeon or the species as a whole. This is because the reduction in numbers will be small and the impact on reproduction and future year classes will also be small enough not to affect the stable trend of the population. The proposed action will have only insignificant effects on habitat and forage and will not impact the river in a way that makes additional growth of the population less likely, that is, it will not reduce the river's carrying capacity. This is because impacts to forage will be insignificant and discountable, and the area of the river that sturgeon will be precluded from (due to high temperatures) is small. The proposed action will not affect shortnose sturgeon outside of the Hudson River. Therefore, because it will not reduce the likelihood that the Hudson River population can recover, it will not reduce the likelihood that the species as a whole can recover. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

9.2 Atlantic sturgeon

As explained above, the proposed action is likely to result in the mortality of 219 New York Bight DPS Atlantic sturgeon. We do not anticipate the mortality of Atlantic sturgeon from any other DPS. Individuals from the Gulf of Maine and Chesapeake Bay DPSs may occur in the action area. These individuals would be exposed to effects of the action including the thermal plume, other pollutants and impacts to prey and habitats. However, all of the effects experienced by Gulf of Maine and Chesapeake Bay DPS Atlantic sturgeon will be insignificant and discountable. Based on the best available information, we do not expect that individuals from the Carolina or South Atlantic DPS will occur in the action area.

9.2.1 New York Bight DPS of Atlantic sturgeon

The NYB DPS has been listed as endangered. While Atlantic sturgeon occur in several rivers in the NYB DPS, recent spawning has only been documented in the Delaware and Hudson rivers. As noted above, we expect all Atlantic sturgeon impinged at Indian Point will originate from the Hudson River. There is limited information on the demographics of the Hudson River population of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007).

No data on abundance of juveniles are available prior to the 1970s; however, catch depletion analysis estimated conservatively that 6,000-6,800 females contributed to the spawning stock during the late 1800s (Secor 2002, Kahnle *et al*. 2005). Two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately 6 year classes, excluding young of year.

In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and 14 wild age-1 Atlantic sturgeon (Peterson *et al*. 2000). A Petersen mark-recapture population estimate from these data suggests that there were 9,529 (95% CI = 1,916 – 10,473) age-0

Atlantic sturgeon in the estuary in 1994. Since 4,929 were stocked, 4,600 fish were of wild origin, assuming equal survival for both hatchery and wild fish and that stocking mortality for hatchery fish was zero.

Information on trends for Atlantic sturgeon in the Hudson River are available from a number of long term surveys. From July to November during 1982-1990 and 1993, the NYSDEC sampled the abundance of juvenile fish in Haverstraw Bay and the Tappan Zee Bay. The CPUE of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since this time.

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which are collected from May-July, provide an annual index of juvenile Atlantic sturgeon in the Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July – October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early 1990s. While the amount of interannual variability makes it difficult to detect short term trends, a five year running average of CPUE from the FJS indicates a slowly increasing trend since about 1996. Interestingly, that is when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003 – 2005, 579 juveniles were collected (N = 122, 208, and 289, respectively) (Sweka et al. 2006). Pectoral spine analysis showed they ranged from 1 – 8 years of age, with the majority being ages 2 – 6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles.

NYB DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. A bycatch estimate provided by NEFSC indicates that approximately 376 Atlantic sturgeon die as a result of bycatch each year. Mixed stock analysis from the NMFS NEFOP indicates that 49% of these individuals are likely to originate from the NYB and 91% of those likely originate from the Hudson River, for a total of approximately 167 adult and subadult mortalities annually. Because juveniles do not leave the river, they are not impacted by fisheries occurring in Federal waters. Bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (shad), has now been closed and there is no indication that it will reopen soon. NYB DPS Atlantic sturgeon are killed as a result of anthropogenic activities in the Hudson River and other rivers; sources of potential mortality include vessel strikes and entrainment in dredges. As noted above, we expect the mortality of two Atlantic sturgeon as a result of the Tappan Zee Bridge replacement project; it is possible that these individuals could originate from the Hudson River. There could also be the loss of a small number of juveniles at other water intakes in the River including the Danskammer and Roseton plants.

The Atlantic sturgeon that will be killed at Indian Point are expected to be juveniles that originate from Hudson River. The most recent estimate of juveniles was 4,600 wild Hudson River juveniles in the 1994 year class. While we have no estimates of the number of juveniles since that time, the available information on trends indicates that there may be a slight increasing trend in juvenile abundance in the Hudson River since the mid-1990s. This suggests that there may be more juveniles in the river now than in 1994. Based on the size of fish impinged in the past, Atlantic sturgeon impinged at IP2 and IP3 are likely to be less than three years old. Even assuming that the three youngest year classes in the Hudson River only have 4,600 individuals each, we would estimate that there are at least 13,800 juvenile Atlantic sturgeon in the Hudson River. We are anticipating a loss of approximately 10 juvenile Atlantic sturgeon per year for 23 years. While there are likely other sources of mortality for juvenile Atlantic sturgeon in the Hudson River, there appears to be a recent increasing trend of juveniles in the river, as evidenced by the upward trend in the 5-year moving average for the FJS CPUE. The closure of the directed Atlantic sturgeon fishery in 1996 and the shad fishery in 2010 are expected to have led to reduced bycatch of juvenile Atlantic sturgeon and subsequently may contribute to increased survival of young sturgeon. It is also important to note that the mortality we are considering here is not a new source of mortality. Any increase in the juvenile population has occurred with the ongoing impingement of individuals at IP2 and IP3.

The mortality of 10 juvenile Atlantic sturgeon annually from the NYB DPS represents a very small percentage of our minimum estimated juvenile population (*i.e.*, approximately 0.09% of the population, just considering the minimum estimated number of Hudson River origin juveniles age 1-3; the percentage would be much less if we also considered the number of adults, subadults and young of year as well as any Delaware River origin sturgeon). While the death of these individuals will reduce the number of NYB DPS Atlantic sturgeon compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this species as this loss represents a very small percentage of the Hudson River population of juveniles and an even smaller percentage of the overall Hudson River population or the DPS as a whole.

Because there will be no loss of adults, the reproductive potential of the NYB DPS will not be affected in any way other than through a reduction in numbers of individual future spawners as opposed to current spawners. The loss of 12 juveniles per year for 23 years would have the effect of reducing the amount of potential reproduction as any dead NYB DPS Atlantic sturgeon would have no potential for future reproduction. This small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individuals that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed action will also not affect the spawning grounds within the Hudson River or Delaware River where NYB DPS fish spawn. We do not anticipate the impingement of any spawning adults. All effects to spawning adults will be insignificant and discountable and there will be no reduction in individual fitness or any future reduction in spawning by these individuals.

The proposed action is not likely to reduce distribution because the action will not impede NYB DPS Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Delaware or Hudson River or elsewhere. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area of the thermal plume.

Based on the information provided above, the death of an average of 102 juvenile NYB DPS Atlantic sturgeon annually for 23 years , will not appreciably reduce the likelihood of survival of the New York Bight DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect NYB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. This is the case because: (1) the death of these juvenile NYB DPS Atlantic sturgeon represents an extremely small percentage of the species; (2) the death of these juvenile NYB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these NYB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these juvenile NYB DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the action will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the action will have no effect on the ability of NYB DPS Atlantic sturgeon to shelter and only an insignificant effect on individual foraging NYB DPS Atlantic sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that shortnose sturgeon can rebuild to a point where the NYB DPS of Atlantic sturgeon is no longer in danger or extinction through all or a significant part of its range.

No Recovery Plan for the NYB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the Hudson River population of Atlantic sturgeon in a way that would affect the NYB DPS likelihood of recovery.

This action will not change the status or trend of the Hudson River population of Atlantic sturgeon or the status and trend of the NYB DPS as a whole. The proposed action will result in a small amount of mortality (an average of 10 juveniles annually from a population of at least 4,600 juveniles and likely at least 24,000 juveniles, just considering the Hudson River and not the DPS as a whole) and a subsequent small reduction in future reproductive output. This reduction in numbers will be small and the impact on reproduction and future year classes will also be small enough not to affect the stable trend of the population. The proposed action will have only insignificant effects on habitat and forage and will not impact the river in a way that makes additional growth of the population less likely, that is, it will not reduce the river's carrying capacity. This is because impacts to forage will be insignificant and discountable and the area of the river that sturgeon will be precluded from (due to high temperatures) is small. The proposed action will not affect Atlantic sturgeon outside of the Hudson River or affect habitats outside of the Hudson River. Therefore, it will not affect estuarine or oceanic habitats that are important for sturgeon. Because it will not reduce the likelihood that the Hudson River population can recover, it will not reduce the likelihood that the NYB DPS as a whole can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered. . Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

11.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the proposed action, interdependent and interrelated actions and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon or the New York Bight DPS of Atlantic sturgeon. We have determined that the proposed action is not likely to adversely affect the Gulf of Maine or Chesapeake Bay DPS of Atlantic sturgeon. No critical habitat is designated in the action area; therefore, none will be affected by the proposed action.

12.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, nonmigratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof." 16 U.S.C. 1532(8). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person "to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]" 16 U.S.C. 1538(g). A "person" is defined in part as any entity subject to the jurisdiction of the United States, including an individual, corporation, officer, employee, department or instrument of the Federal government (see 16 U.S.C. 1532(13)). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by NRC and the applicant, Entergy, for the exemption in section 7(o)(2) to apply. NRC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NRC (1) fails to assume and implement the terms and conditions consistent with its authority or (2) fails to require the applicant, Entergy, to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the renewed license consistent with its authority, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NRC or the applicant must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

12.1 Amount or Extent of Take

This ITS serves two important functions: (1) it provides an exemption from the Section 9 prohibitions for any taking incidental to the proposed action that is in compliance with the terms and conditions; and (2) it provides the means to insure the action as it is carried out is not jeopardizing the continued existence of affected species by monitoring and reporting the progress of the action and its impact on the species such that consultation can be reinitiated if any of the criteria in 50 CFR 402.16 are met. This ITS applies to the remaining term of the existing operating licenses and any extended operating period through the expiration date of those licenses. As such, we anticipate that this amount of take will occur at IP2, from now through September 28, 2033 and at IP3 until December 12, 2035. Take will also occur at the IP1 intakes as long as they are used for service water for IP2 which will occur from now until the IP2 license expires on September 28, 2033. The continued operation of IP2 and IP3 will adversely affect shortnose and Atlantic sturgeon due to impingement at the IP1, IP2 and IP3 intakes. These interactions at the intakes constitute “capture” or “collect” in the definition of “take” and will cause injury and mortality to the affected individuals. All impinged sturgeon are expected to die, immediately or later, as a result of interactions with the facility. As explained in the “Effects of the Action” section, effects of the facility on shortnose and Atlantic sturgeon also include effects of the thermal plume on distribution and prey. However, based on the available information on the thermal plume and the assumptions regarding sturgeon behavior and thermal tolerances outlined in the Opinion, we do not anticipate or exempt any take of shortnose or Atlantic sturgeon due to effects to prey items or due to exposure to the thermal plume.

We recognize that some sturgeon impinged at Indian Point may be dead prior to impingement. While it is possible the cause of death is unrelated to the operation of Indian Point, we do not currently have any information to determine whether that is the case. The take level that is exempted is inclusive of “previously killed” fish; this ITS exempts the “collection” or “capture” of these previously killed fish. At this time, because there are no necropsy reports for any sturgeon collected at Indian Point and very little data on the condition of impinged shortnose and Atlantic sturgeon (other than “dead” or “alive” for a few fish), we are unable to predict what percent of the impinged sturgeon are likely to have been killed prior to impingement at Indian Point. Future monitoring, as required by the RPMs and Terms and Conditions, will enable the ITS to serve its function of supporting the reinitiation provision.

This ITS exempts the following take:

- A total of 562 shortnose sturgeon (dead or alive) impinged at the Unit 1[15], 2, or 3 intakes (trash bars or screens) from now until the IP3 proposed renewed operating license would expire on December 12, 2035; and,
- A total of 219 New York Bight DPS Atlantic sturgeon (dead or alive) impinged at Unit 1, 2 or 3 intakes (trash bars or Ristroph screens) from now until the IP3 proposed renewed operating license would expire on December 12, 2035.

The Section 9 prohibitions against take apply to live individuals as well as to dead specimens and their parts. The Section 9 prohibitions include “capture” and “collect” in the definition of take, as well as injury and mortality. NMFS recognizes that shortnose and Atlantic sturgeon that have been killed prior to impingement at the IP facility may become impinged on the intakes at IP1, IP2 and IP3. However, the capture or collection of previously dead animals is prohibited under Section 9 and will be exempted through this ITS. Additionally, NMFS recognizes the potential for some shortnose and Atlantic sturgeon to pass through the trash bars, contact the Ristroph screens and travel down the sluice back to the River without significant injury or mortality. The Section 9 prohibitions on take also apply to the capture or collection of live, uninjured animals

[15] As explained in the Opinion, water withdrawn through the Unit 1 intakes is used for service water for the operation of IP2.

even if these animals are released without injury. Thus, it is appropriate for this ITS to also address shortnose and Atlantic sturgeon that may be captured or collected at the Ristroph screens and returned to the river unharmed. As no monitoring has taken place at the intakes since 1990, we cannot predict what percentage of sturgeon would be collected at the Ristroph screens without injury or mortality and, therefore, we are not able to refine this estimate of take to separate out the number of fish that may be collected but not killed. Due to the difficulty in determining the cause of death of sturgeon found dead at the intakes and the lack of past necropsy results that would allow us to better assess the likely cause of death of impinged sturgeon, the aforementioned anticipated level of take includes shortnose and Atlantic sturgeon that may have been killed prior to impingement on the IP intakes. As explained in the Opinion, we do not have sufficient information to predict what percentage of impinged sturgeon were previously killed and merely captured or collected at the facility and sturgeon that died as a result of their impingement at the Indian Point intakes. Therefore, we are not able to further refine this estimate of take into a number of previously dead sturgeon captured or collected at the facility and a number of sturgeon whose death was caused by operation of the facility. In the accompanying Opinion, we determined that this level of anticipated take is not likely to result in jeopardy to shortnose sturgeon or to any DPS of Atlantic sturgeon.

12.2 Reasonable and Prudent Measures

In order to effectively monitor the effects of this action, it is necessary to monitor the intakes to document the amount of incidental take (i.e., the number of shortnose and Atlantic sturgeon captured, collected, injured or killed) and to examine the shortnose and Atlantic sturgeon that are impinged at the facility. Monitoring minimizes take by providing information on the characteristics of the sturgeon encountered and factors related to interactions that is useful for judging the effectiveness of current measures and for developing more effective measures to avoid future interactions with listed species. Monitoring also serves to check the assumptions and conclusions in the Opinion's analysis, thereby enabling NRC and NMFS to know whether reinitiation of consultation is necessary. We do not anticipate any additional injury or mortality to be caused by removing the fish from the water and examining them as required in the RPMs. Any live sturgeon are to be released back into the river, away from the intakes and thermal plume. These RPMs and their implementing terms and conditions apply to operations of IP2 and IP3 under their existing licenses as well as the license to be issued for the continued operation of IP2 and the license to be issued for the continued operation of IP3. We expect that the NRC will amend the operating licenses to incorporate these RPMs and Terms and Conditions as appropriate.

We have determined the following reasonable and prudent measures are necessary or appropriate to minimize and monitor impacts of incidental take of endangered shortnose and Atlantic sturgeon:

1. A program to monitor the incidental take of shortnose and Atlantic sturgeon at the IP1, IP2 and IP3 intakes must be developed, approved by NMFS, and implemented within 120 days of the issuance of this Opinion. This program must be implemented throughout the remaining duration of the existing operating licenses and for the entire duration of any new operating licenses.

2. All live shortnose and Atlantic sturgeon must be released back into the Hudson River at an appropriate location away from the intakes and thermal plume that does not pose additional risk of take, including death, injury, harassment, collection/capture.

3. Any dead shortnose or Atlantic sturgeon must be transferred to NMFS or an appropriately permitted research facility NMFS will identify so that a necropsy can be undertaken to attempt to determine the cause of death.

4. A genetic sample must be taken of all Atlantic and shortnose sturgeon impinged at Indian Point.

5. All shortnose and Atlantic sturgeon impingements associated with the Indian Point facility and any shortnose or Atlantic sturgeon sightings in the action area must be reported to NMFS.

12.3 Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, Entergy must comply with, and NRC, consistent with its authorities, must ensure through enforceable terms of the existing and renewed licenses that Entergy does comply with, the following terms and conditions of the Incidental Take Statement, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned (ESA Section 7(o)(2)). Within 60 days of issuance of this Opinion, NRC must add a condition(s) to the existing licenses and to the proposed renewed licenses that requires Entergy to adhere to the terms and conditions of this Opinion.

1. To implement RPM #1, Entergy must fully implement a NMFS-approved monitoring plan within 120 days of the issuance of this Opinion. A draft monitoring plan must be provided to NMFS within 30 days of the issuance of this Opinion for NMFS review and approval. The monitoring plan must be implemented throughout the remaining term of the existing operating licenses and any period beyond their expiration that the facilities continue to operate pursuant to those licenses. The monitoring plan must also be implemented through the duration of the operating period authorized by any new operating licenses. The monitoring plan must be designed and implemented to allow for the detection and observation of all shortnose and Atlantic sturgeon that are impinged anywhere at the intakes, including on the trash bars, or that contact the Ristroph screens or its fish buckets. All references to “Ristroph screens” below are inclusive of all parts of the Ristroph screen system including the screening itself, the fish buckets, and the fish return system. This monitoring plan must contain the following components:
    a. methods and procedure for monitoring the intake trash bars on a schedule that ensures detection and timely release of all shortnose and Atlantic sturgeon impinged on the trash bars;
    b. any method developed to monitor the intake trash bars for shortnose and Atlantic sturgeon must be able to detect all individuals impinged at the trash bars within 24 hours of impingement;

c. methods and procedures for monitoring the Ristroph screens on a schedule that ensures detection and timely release of all shortnose and Atlantic sturgeon that pass through the trash bars and contact or are impinged on the screens;
d. any method developed to monitor the Ristroph screens must ensure the detection and inspection of all shortnose and Atlantic sturgeon prior to their being discharged back into the River;
e. a handling and release plan that describes how all live shortnose and Atlantic sturgeon that are impinged at the trash bars or the Ristroph screens will be safely removed from the water, handled for examination, and returned to the River;
f. handling and disposal procedures for dead shortnose and Atlantic sturgeon or body parts of shortnose and Atlantic sturgeon;
g. procedures for obtaining genetic samples from all shortnose and Atlantic sturgeon;
h. reporting forms that contain all information to be reported for all incidental takes of shortnose and Atlantic sturgeon;
i. procedures for notifying NMFS of all incidental takes;
j. monitoring the water velocity at the trash bars (approach and through-rack velocity), between the trash bars and Ristroph screens and at the Ristroph screens (approach and through-screen velocity) at IP1, IP2 and IP3 so that this information can be reported any time a take occurs;
k. monitoring water temperature at the trash bars and at the Ristroph screens at IP1, IP2 and IP3 so that this information can be reported any time a take occurs (surface, mid-water and bottom water);
l. monitoring operating conditions so that this information can be reported any time a take occurs;
m. coordination procedures regarding personnel who will be carrying out this monitoring. Qualifications must be submitted to NMFS for review and approval. All monitors will need to demonstrate experience in identifying and handling sturgeon species.

and,

n. procedures for making any necessary updates or modifications to the monitoring plan.

2. To implement RPM #1, At least 60 days prior to the issuance of the renewed operating license(s), NMFS must receive a copy of a proposed renewed monitoring plan for our approval. At that time, NMFS, the licensee and NRC must determine if any improvements to the existing monitoring plan are necessary. This proposed renewed monitoring plan must be approved by NMFS prior to the effective date of any renewed license(s) and must be implemented beginning on the day that the new license(s) becomes effective and carried out throughout the duration of those licenses.

3. To implement RPM #2, Entergy must ensure that all live shortnose and Atlantic sturgeon are returned to the river away from the intakes and the thermal plume, following complete documentation of the event pursuant to the approved monitoring plans and forms provided with this ITS. Handling and release procedures must be a part of the monitoring plan outlined in Term and Condition #1.

4. To implement RPM #3, Entergy must ensure that all dead specimens or body parts of shortnose and Atlantic sturgeon or fish that might be sturgeon are photographed, measured, and preserved (refrigerate or freeze). No dead shortnose or Atlantic sturgeon or body parts of shortnose or Atlantic sturgeon may be disposed without discussing disposal procedures with NMFS. General disposal procedures must be included in the monitoring plan outlined in Term and Condition #1 above. NMFS may request that the specimen be transferred to NMFS or to an appropriately permitted researcher so that a necropsy may be conducted. The forms included as Appendix II and III must be completed and submitted to NMFS as noted in Term and Condition #7.

5. To implement RPM#4, Entergy must obtain genetic samples from all captured or impinged Atlantic and shortnose sturgeon. This must be done in accordance with the procedures provided in Appendix IV.

6. To implement RPM #5, if any live or dead shortnose or Atlantic sturgeon are taken at IP1, IP2 or IP3, Entergy must notify NMFS (978-281-9328 and incidental.take@noaa.gov) and NRC immediately. An incident report (Appendix I) must also be completed by plant personnel and sent to the NMFS Section 7 Coordinator via e-mail (incidental.take@noaa.gov) within 24 hours of the take. The form included as Appendix III must be filled out for any dead sturgeon and submitted via e-mail (incidental.take@noaa.gov) within 24 hours of the take. Every shortnose and Atlantic sturgeon, must be photographed and photographs must be submitted to NMFS within 24 hours. Information in Appendix V will assist in identification of shortnose and Atlantic sturgeon.

7. To implement RPM #5, Entergy must notify NMFS and NRC in writing when the facility reaches 50% of the annual estimated incidental take level for shortnose and Atlantic sturgeon (12 and 5 individuals, respectively). At that time, NMFS will determine if additional measures are necessary or appropriate to minimize impingement at the intake structures, or if additional monitoring is necessary, in order to avoid exceeding the incidental take levels specified in this Incidental Take Statement.

8. To implement RPM #5, Entergy must notify NMFS and NRC in writing any time the facility exceeds the annual estimated incidental take level for shortnose and Atlantic sturgeon (25 and 10 individuals, respectively). At that time, NMFS will determine if this annual exceedence represents new information that would necessitate reinitiation of consultation.

8. To implement RPM #5, Entergy must submit an annual report of incidental takes to NMFS and NRC by February 15 of each year. The report must include, as detailed in this Incidental Take Statement and the monitoring plan required by Term and Condition #1, any necropsy reports of specimens, incidental take reports, photographs , a record of all sightings of shortnose and Atlantic sturgeon in the vicinity of Indian Point, conditions at the time of the take (operations as well as environmental conditions including water velocity and water temperature) and a record of when inspections of the intake trash bars and Ristroph screens were conducted for the 48 hours prior to the take. The annual report must also identify any potential measures to reduce shortnose or Atlantic sturgeon

impingement, injury, and mortality at the intake structures. At the time the report is submitted, NMFS will supply NRC and Entergy with any information on changes to reporting requirements (i.e., staff changes, phone or fax numbers, e-mail addresses) for the coming year.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that results from the proposed action. Specifically, these RPMs and Terms and Conditions will ensure that Entergy monitors the intakes in a way that allows for the detection of all impinged shortnose and Atlantic sturgeon and implements measures to reduce the potential of mortality for all shortnose and Atlantic sturgeon impinged at Indian Point, to report all interactions to NMFS and NRC and to provide information on the likely cause of death of any shortnose and Atlantic sturgeon impinged at the facility. The discussion below explains why each of these RPMs and Terms and Conditions are necessary or appropriate to minimize or monitor the level of incidental take associated with the proposed action. The RPMs and terms and conditions involve only a minor change to the proposed action.

RPM #1 and Term and Condition #1 and 2 are necessary and appropriate because they are specifically designed to ensure that all appropriate measures are carried out to monitor the incidental take of sturgeon at Indian Point, which by definition includes the capture or collection of live sturgeon as well as the injury or mortality of impinged sturgeon. An effective monitoring plan is essential to allow NRC and Entergy to fulfill the requirement to monitor the actual level of incidental take associated with the operation of Indian Point and to allow NMFS and NRC to determine if consultation must be reinitiated. These requirements are also essential for confirming the cause of death. These conditions ensure that the potential for detection of shortnose and Atlantic sturgeon at the intakes is maximized and that any sturgeon removed from the water are removed in a manner that minimizes the potential for further injury.

RPM#2 and Term and Condition #3 are necessary and appropriate to ensure that any shortnose or Atlantic sturgeon that survive impingement is given the maximum probability of remaining alive and not suffering additional injury or subsequent mortality through inappropriate handling or release near the intakes.

RPM #3 and Term and Condition #4 are necessary and appropriate to ensure the proper handling and documentation of any shortnose and Atlantic sturgeon removed from the intakes that are dead or die while in Entergy possession. This is essential for monitoring the level of incidental take associated with the proposed action, confirming cause of death and ensuring proper disposal.

RPM #4 and Term and Condition #5 are necessary and appropriate to ensure the proper documentation of species and/or DPS of origin for any impinged sturgeon collected at Indian Point. Sampling of fin tissue is used for genetic sampling. This procedure does not harm shortnose or Atlantic sturgeon and is common practice in fisheries science. Tissue sampling does not appear to impair the sturgeon’s ability to swim and is not thought to have any long-term adverse impact. NMFS has received no reports of injury or mortality to any shortnose or Atlantic sturgeon sampled in this way.

RPM#5 and Term and Condition #6-8 are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as the prompt reporting of these interactions to NMFS.

13.0 CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. As such, NMFS recommends that the NRC consider the following Conservation Recommendations:

1. The NRC should use its authorities to ensure tissue analysis of dead shortnose sturgeon removed from the Indian Point intakes is performed to determine contaminant loads, including radionuclides.

2. The NRC should use its authorities to ensure studies are performed that document impacts of impingement, entrainment and heat shock to benthic resources that may serve as forage for shortnose and Atlantic sturgeon.

3. The NRC should use its authorities to ensure studies are performed to ground truth the thermal plume model published in 2011 (Swanson et al. 2011) with field sampling across a range of environmental conditions (weather, tide, etc.).

4. The NRC should use its authorities to require that the REMP sample species that may serve as forage for shortnose and Atlantic sturgeon.

5. The NRC should use its authorities to ensure a scientific study on the mortality of sturgeon impinged on Ristroph Screens is performed.

6. The NRC should use its authorities to ensure in-water assessments, abundance, and distribution surveys for shortnose and Atlantic sturgeon in the Hudson River, and Haverstraw Bay specifically, are performed.

7. The NRC should use its authorities to ensure studies are performed that document the presence, if any, of shortnose sturgeon in the broadest area affected by the thermal plume in order to validate the assumption in this Opinion that shortnose sturgeon are likely to move away from the thermal plume.

14.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the continued operation of IP2 and IP3 under the terms of the existing operating licenses and the proposed renewed operating licenses. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

If in the future, NY State issues a revised SPDES permit or 401 WQC that modifies the operations of IP2 or IP3, reinitiation of this consultation is likely to be necessary. Additionally, it is our understanding that revised CWA 316(b) regulations may be issued by EPA in 2013. If there are any modifications to the Indian Point facility resulting from the implementation of these regulations, reinitiation of this consultation is likely to be necessary.

15.0 LITERATURE CITED

Allen PJ, Nicholl M, Cole S, Vlazny A, Cech JJ Jr. 2006. Growth of larval to juvenile green sturgeon in elevated temperature regimes. Trans Am Fish Soc 135:89–96

ASA (Analysis and Communication). 2008. 2006 year class report for the Hudson River Estuary Program prepared for Dynegy Roseton LLC, on behalf of Dynegy Roseton LLC Entergy Nuclear Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, and Mirant Bowline LLC. Washingtonville NY.

Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M., K. Arend, N. Haley, S. Hayes, J. Knight, S. Nack, D. Peterson, and M. Walsh. 1998a. Sturgeon of the Hudson River: Final Report on 1993-1996 Research. Prepared for The Hudson River Foundation by the Department of Natural Resources, Cornell University, Ithaca, New York.

Bain, Mark B., D.L. Peterson, K. K. Arend. 1998b. Population status of shortnose sturgeon in the Hudson River: Final Report. Prepared for Habitat and Protected Resources Division National Marine Fisheries Service by New York Cooperative Fish and Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY.

Bain, Mark B., N. Haley, D. L. Peterson, K. K. Arend, K. E. Mills, P. J. Sullivan. 2000. Annual meeting of American fisheries Society. EPRI-AFS Symposium: Biology, Management and Protection of Sturgeon. St. Louis, MO. 23-24 August 2000.

Bain, Mark B., N. Haley, D. L. Peterson, K. K Arend, K. E. Mills, P. J. Sulivan. 2007. Recovery of a US Endangered Fish. PLoS ONE 2(1): e168. doi:10.1371/journal.pone.0000168

Bath, D.W., J.M. O'Conner, J.B. Albert and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrinchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981:711-717.

Beamesderfer, Raymond C.P. and Ruth A. Farr. 1997. Alternatives for the protection and restoration of sturgeons and their habitat. Environmental Biology of Fishes 48: 407-417.

Berlin, W.H., R.J. Hesselberg, and M.J. Mac. 1981. Chlorinated hydrocarbons as a factor in the reproduction and survival of lake trout (Salvelinus namaycush) in Lake Michigan. Technical Paper 105 of the U.S. Fish and Wildlife Service, 42 pages.

Buckley, J., and B. Kynard. 1981. Spawning and rearing of shortnose sturgeon from the Connecticut River. Progressive Fish Culturist 43:74-76.

Buckley, J. and B. Kynard. 1985. Habitat use and behavior of pre-spawing and spawning shortnose sturgeon, *Acipenser brevirostrum*, in the Connecticut River. North American Sturgeons: 111-117.

Carlson, D.M., and K.W. Simpson. 1987. Gut contents of juvenile shortnose sturgeon in the upper Hudson estuary. Copeia 1987:796-802

CHGE. Central Hudson Gas and Electric Corp., Consolidated Edison Company of New York, New York Power Authority, and Southern Energy New York. 1999. Draft environmental impact statement for State pollution discharge elimination system permits for Bowline Point1&2, Indian Point 1&2, and Roseton 1&2 Steam electric generating stations.

Collins, M. R., S. G. Rogers, and T. I. J. Smith. 1996. Bycatch of sturgeons along the Southern Atlantic Coast of the USA. North American Journal of Fisheries Management 16: 24-29.

Dadswell, M.J. 1979. Biology and population characteristics of the shortnose sturgeon, Acipenser brevirostrum LeSueur 1818 (Osteichthyes: Acipenseridae), in the Saint John River estuary, New Brunswick, Canada. Canadian Journal of Zoology 57:2186-2210.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* Lesueur 1818. NOAA Technical Report, NMFS 14, National Marine Fisheries Service. October 1984 45 pp.

Dovel, W.J. 1978. The Biology and management of shortnose and Atlantic sturgeons of the Hudson River. Performance report for the period April 1, to September 30, 1978. Submitted to N.Y. State Department of Environmental Conservation.

Dovel, W.J. 1979. Biology and management of shortnose and Atlantic sturgeon of the Hudson River. New York State Department of Environmental Conservation, AFS9-R, Albany.

Dovel, W.L. 1981. The Endangered shortnose sturgeon of the Hudson Estuary: Its life history and vulnerability to the activities of man. The Oceanic Society. FERC Contract No. DE-AC 39-79 RC-10074.

Dovel, W.L., A.W. Pekovitch, and T.J. Berggren. 1992. Biology of the shortnose sturgeon (*Acipenser brevirostrum* Lesueur 1818) in the Hudson River estuary, New York. Pages 187-216 in C.L. Smith (editor). Estuarine research in the 1980s. State University of New York Press, Albany, New York.

Dwyer, F. James, Douglas K. Hardesty, Christopher G. Ingersoll, James L. Kunz, and David W. Whites. 2000. Assessing contaminant sensitivity of American shad, Atlantic sturgeon, and shortnose sturgeon. Final Report. U.S. Geological Survey. Columbia Environmental Research Center, 4200 New Have Road, Columbia, Missouri.

Entergy Nuclear Operations, Inc. (Entergy). 2007a. “Indian Point, Units 2 & 3, License Renewal Application.” April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. “Applicant’s Environment Report, Operating License Renewal Stage." (Appendix E to "Indian Point, Units 2 & 3, License Renewal Application".) April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from Fred Dacimo, Indian Point Energy Center Site Vice President, to the U.S. NRC regarding Indian Point Nuclear Generating Units Nos. 2 and 3. Docket Nos. 50-247, 50-286. May 3, 2007.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2002. Contaminant analysis of tissues from two shortnose sturgeon (Acipenser brevirostrum) collected in the Delaware River. Prepared for National Marine Fisheries Service. 16 pp. + appendices.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2007. Preliminary acoustic tracking study of juvenile shortnose sturgeon and Atlantic sturgeon in the Delaware River. May 2006 through March 2007. Prepared for NOAA Fisheries. 9 pp.

Eyler, Sheila M., Jorgen E. Skjeveland, Michael F. Mangold, and Stuart A. Welsh. 2000. Distribution of Sturgeons in Candidate Open Water Dredged Material Placement Sites in the Potomac River (1998-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 26 pp.

Fernandes, S.J. 2008. Population demography, distribution, and movement patterns of Atlantic and shortnose sturgeons in the Penobscot River estuary, Maine. University of Maine. Masters thesis. 88 pp.

Fletcher, R. I. 1990. Flow dynamics and fish recovery experiments: water intake systems. Transactions of the American Fisheries Society. Vol. 119, No. 3, pp. 393-415.

Flournoy, P.H., S.G. Rogers, and P.S. Crawford. 1992. Restoration of shortnose sturgeon in the Altamaha River, Georgia. Final Report to the U.S. Fish and Wildlife Service, Atlanta, Georgia.

Geoghegan, P., M.T. Mattson and R.G Keppel. 1992. Distribution of shortnose sturgeon in the Hudson River, 1984-1988. IN Estuarine Research in the 1980s, C. Lavett Smith, Editor. Hudson River Environmental Society, Seventh symposium on Hudson River ecology. State University of New York Press, Albany NY, USA.

Giesy, J.P., J. Newsted, and D.L. Garling. 1986. Relationships between chlorinated hydrocarbon concentrations and rearing mortality of chinook salmon (Oncorhynchus tshawytscha) eggs from Lake Michigan. Journal of Great Lakes Research 12(1):82-98.

Gilbert, C.R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82, 28 pages.

Grunwald, C., J. Stabile, J.R. Waldman, R. Gross, and I. Wirgin. 2002. Population genetics of shortnose *sturgeon (Acipenser brevirostrum*) based on mitochondrial DNA control region sequences. Molecular Ecology 11: 000-000.

Hansen, P.D. 1985. Chlorinated hydrocarbons and hatching success in Baltic herring spring spawners. Marine Environmental Research 15:59-76.

Haley, N. 1996. Juvenile sturgeon use in the Hudson River Estuary. Master's thesis. University of Massachusetts, Amhearst, MA, USA.

Hall, W.J., T.I.J. Smith, and S.D. Lamprecht. 1991. Movements and habitats of shortnose sturgeon Acipenser brevirostrum in the Savannah River. Copeia (3):695-702.

Hastings, R.W. 1983. A study of the shortnose sturgeon (*Acipenser brevirostrum*) population in the upper tidal Delaware River: Assessment of impacts of maintenance dredging. Final Report to the U.S. Army Corps of Engineers, Philadelphia, Pennsylvania. 129 pp.

Heidt, A.R., and R.J. Gilbert. 1978. The shortnose sturgeon in the Altamaha River drainage, Georgia. Pages 54-60 in R.R. Odum and L. Landers, editors. Proceedings of the rare and endangered wildlife symposium. Georgia Department of Natural Resources, Game and Fish Division, Technical Bulletin WL 4, Athens, Georgia.

Holland, B.F., Jr. and G.F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources, Division of Commercial and Sports Fisheries, Morehead City. Special Scientific Report 24:1-132.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43: 617-627.IPCC (Intergovernmental Panel on Climate Change) 2007. Fourth Assessment Report. Valencia, Spain.

Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1993. Tolerance of shortnose sturgeon, *Acipenser brevirostrum*, juveniles to different salinity and dissolved oxygen concentrations. Proceedings of the Southeast Association of Fish and Wildlife Agencies, Atlanta, Georgia.

Kieffer, M.C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 1221: 1088-1103.

Kieffer, M., and B. Kynard. 1996. Spawning of shortnose sturgeon in the Merrimack River. Transactions of the American Fisheries Society 125:179-186.

Kieffer and Kynard in review [book to be published by AFS]. Kieffer, M. C., and B. Kynard. In review. Pre-spawning and non-spawning spring migrations, spawning, and effects of hydroelectric dam operation and river regulation on spawning of Connecticut River shortnose sturgeon.

Kocan, R.M., M.B. Matta, and S. Salazar. 1993. A laboratory evaluation of Connecticut River coal tar toxicity to shortnose sturgeon (*Acipenser brevirostrum)* embryos and larvae. Final

Report to the National Oceanic and Atmospheric Administration, Seattle, Washington.

Kynard, B. 1996. Twenty-one years of passing shortnose sturgeon in fish lifts on the Connecticut River: what has been learned? Draft report by National Biological Service, Conte Anadromous Fish Research Center, Turners Falls, MA. 19 pp.

Kynard, B. 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon, Acipenser brevirostrum. Environmental Biology of Fishes 48:319–334.

Longwell, A.C., S. Chang, A. Hebert, J. Hughes and D. Perry. 1992. Pollution and developmental abnormalities of Atlantic fishes. Environmental Biology of Fishes 35:1- 21.

Mac, M.J., and C.C. Edsall. 1991. Environmental contaminants and the reproductive success of lake trout in the Great Lakes: An epidemiological approach. Journal of Toxicology and Environmental Health 33:375-394.

Mayfield RB, Cech JJ Jr. 2004. Temperature effects on green sturgeon bioenergetics. Trans Am Fish Soc 133:961–970

Morgan, R.P., V.J. Rasin and L.A. Noe. 1973. Effects of Suspended Sediments on the Development of Eggs and Larvae of Striped Bass and White Perch. Natural resources Institute, Chesapeake Biological Laboratory, U of Maryland, Center for Environmental and Estuarine Studies. 20 pp.

Moser, M.L. and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234.

NAST (National Assessment Synthesis Team). 2008. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000
http://www.usgcrp.gov/usgcrp/Library/nationalassessment/1IntroA.pdf

NMFS, 1996. Status Review of shortnose sturgeon in the Androscoggin and Kennebec Rivers. Northeast Regional Office, National Marine Fisheries Service, unpublished report. 26 pp.

NMFS. 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.

NOAA. 1979. Testimony of Dr. Dadswell. May 14, 1979. Docket C/II-WP-77-01.

NRC 2010. Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Supplement 38 – Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3. Final Report. NUREG-1437, Supplement 38

NRC 2009. Biological Assessment to NMFS for Indian Point relicensing. Unpublished report transmitted to NMFS.

NRC 2010b. Revised Biological Assessment to NMFS for Indian Point relicensing. December 2010.

NRC 2011. Supplement to Biological Assessment to NMFS for Indian Point relicensing.

NYHS (New York Historical Society as cited by Dovel as Mitchell. S. 1811). 1809. Volume1. Collections of the New-York Historical Society for the year 1809.

NYDEC. 1982. State Pollution Discharge Elimination System Final Permit for Indian Point Nuclear Generating Station.

NYSDEC (New York State Department of Environmental Conservation). 2003. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2 Bowline 1 and 2 and IP2 and IP3 2 and 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties" (Hudson River Power Plants FEIS). June 25, 2003.

NYDEC. 2010. Letter from W. Adriance to D. Grey, Entergy. Denial of 401 WQC. April 2, 2010.

Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (Acipenser oxyrinchus and A. brevirostrum) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.

O'Herron, J.C., K.W. Able, and R.W. Hastings. 1993. Movements of shortnose sturgeon (*Acipenser brevirostrum)* in the Delaware River. Estuaries 16:235-240.

Parker E. 2007. Ontogeny and life history of shortnose sturgeon (*Acipenser brevirostrum* lesueur 1818): effects of latitudinal variation and water temperature. Ph.D. Dissertation. University of Massachusetts, Amherst. 62 pp.

Pekovitch, A.W. 1979. Distribution and some life history aspects of shortnose sturgeon (*Acipenser brevirostrum)* in the upper Hudson River Estuary. Hazleton Environmental Sciences Corporation. 67 pp.

Rogers, S. G., and W. Weber. 1994. Occurrence of shortnose sturgeon (Acipenser brevirostrum) in the Ogeechee-Canoochee river system, Georgia during the summer of 1993. Final Report of the United States Army to the Nature Conservancy of Georgia.

Rogers, S.G., and W. Weber. 1995a. Movements of shortnose sturgeon in the Altamaha River system, Georgia. Contributions Series #57. Coastal Resources Division, Georgia Department of Natural Resources, Brunswick, Georgia.

Rogers, S.G., and W. Weber. 1995b. Status and restoration of Atlantic and shortnose sturgeons in Georgia. Final Report to the National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.

Ruelle, R., and K.D. Keenlyne. 1993. Contaminants in Missouri River pallid sturgeon. Bull. Environ. Contam. Toxicol. 50: 898-906.

Ruelle, R. and C. Henry. 1994. Life history observations and contaminant evaluation of pallid sturgeon. Final Report U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, South Dakota Field Office, 420 South Garfield Avenue, Suite 400, Pierre, South Dakota 57501-5408.

Sherk, J.A. J.M. O'Connor and D.A. Neumann. 1975. Effects of suspended and deposited sediments on estuarine environments. *In*: Estuarine Research Vol. II. Geology and Engineering. L.E. Cronin (editor). New York: Academic Press, Inc.

Skjeveland, Jorgen E., Stuart A. Welsh, Michael F. Mangold, Sheila M. Eyler, and Seaberry Nachbar. 2000. A Report of Investigations and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake bay (1996-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 44 pp.

Smith, Hugh M. and Barton A. Bean. 1899. List of fishes known to inhabit the waters of the District of Columbia and vicinity. Prepared for the United States Fish Commission. Washington Government Printing Office, Washington, D.C.

Snyder, D.E. 1988. Description and identification of shortnose and Atlantic sturgeon larvae. American Fisheries Society Symposium 5:7-30.

Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. U.S. Fish and Wildlife Service, Charles City, Virginia.

Squiers, T., L. Flagg, and M. Smith. 1982. American shad enhancement and status of sturgeon stocks in selected Maine waters. Completion report, Project AFC-20.

Squiers, T. And M. Robillard. 1997. Preliminary report on the location of overwintering sites for shortnose sturgeon in the estuarial complex of the Kennebec River during the winter of 1996/1997. Unpublished report, submitted to the Maine Department of Transportation.

Swanson, C., D. Crowley, Y. Kim, N. Cohn, and D. Mendelsohn. 2011a. Part 2 of Response to the NYSDEC Staff Review of the 2010 Field Program and Modeling Analyis of the Cooling Water Discharge from the Indian Point Energy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. ML 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Swanson, C., D. Mendelsohn, N. Cohn, D. Crowley, Y. Kim, L Decker, and L Miller. 2011 b. Final Report: 2010 Field Program and Modeling Analysis of the Cooling Water Discharge from the Indian Point Entergy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. **ML** 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Taubert, B.D. 1980b. Biology of shortnose sturgeon (Acipenser brevirostrum) in the Holyoke Pool, Connecticut River, Massachusetts. Ph.D. Thesis, University of Massachusetts, Amherst, 136 p.

Taubert, B.D., and M.J. Dadswell. 1980. Description of some larval shortnose sturgeon (Acipenser brevirostrum) from the Holyoke Pool, Connecticut River, Massachusetts, USA, and the Saint John River, New Brunswick, Canada. Canadian Journal of Zoology 58:1125-1128.

Uhler, P.R. and O. Lugger. 1876. List of fishes of Maryland. Rept. Comm. Fish. MD. 1876: 67-176.

USDOI (United States Department of Interior). 1973. Threatened wildlife of the United States. Shortnose sturgeon. Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, Washington, D.C. Resource Publication 114 (Revised Resource Publication 34).

Varanasi, U. 1992. Chemical contaminants and their effects on living marine resources. pp. 59-71. in: R. H. Stroud (ed.) Stemming the Tide of Coastqal Fish Habitat Loss. Proceedings of the Symposium on Conservation of Fish Habitat, Baltimore, Maryland. Marine Recreational Fisheries Number 14. National Coalition for Marine Conservation, Inc., Savannah Georgia.

Vinyard, L. and W.J. O'Brien. 1976. Effects of light and turbidity on the reactive distance of bluegill (*Lepomis macrochirus*) J. Fish. Res. Board Can. 33: 2845-2849.

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidea. Pages 24-60 in Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(Part III). xxi + 630 pp.

Von Westernhagen, H., H. Rosenthal, V. Dethlefsen, W. Ernst, U. Harms, and P.D. Hansen. 1981. Bioaccumulating substances and reproductive success in Baltic flounder Platichthys flesus. Aquatic Toxicology 1:85-99.

Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L. and J. Waldman. 2005. Range-wide population structure of shortnose sturgeon Acipenser brevirostrum based on sequence analysis of mitochondrial DNA control region. Estuaries 28:406-21.

Waldman JR, Grunwald C, Stabile J, Wirgin I. 2002. Impacts of life history and biogeography on genetic stock structure in Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, Gulf sturgeon *A. oxyrinchus desotoi*, and shortnose sturgeon, *A.brevirostrum.* J Appl Ichthyol 18:509-518

Walsh, M.G., M.B. Bain, T. Squires, J.R. Walman, and Isaac Wirgin. 2001. Morphological and genetic variation among shortnose sturgeon Acipenser brevirostrum from adjacent and distant rivers. Estuaries Vol. 24, No. 1, p. 41-48. February 2001.

Waters, Thomas F. 1995. Sediment in Streams. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, MD. Pages 95-96.

Weber, W. 1996. Population size and habitat use of shortnose sturgeon, Acipenser brevirostrum, in the Ogeechee River sytem, Georgia. Masters Thesis, University of Georgia, Athens, Georgia.

Welsh, Stuart A., Michael F. Mangold, Jorgen E. Skjeveland, and Albert J. Spells. 2002. Distribution and Movement of Shortnose Sturgeon (*Acipenser brevirostrum*) in the Chesapeake Bay. Estuaries Vol. 25 No. 1: 101-104.

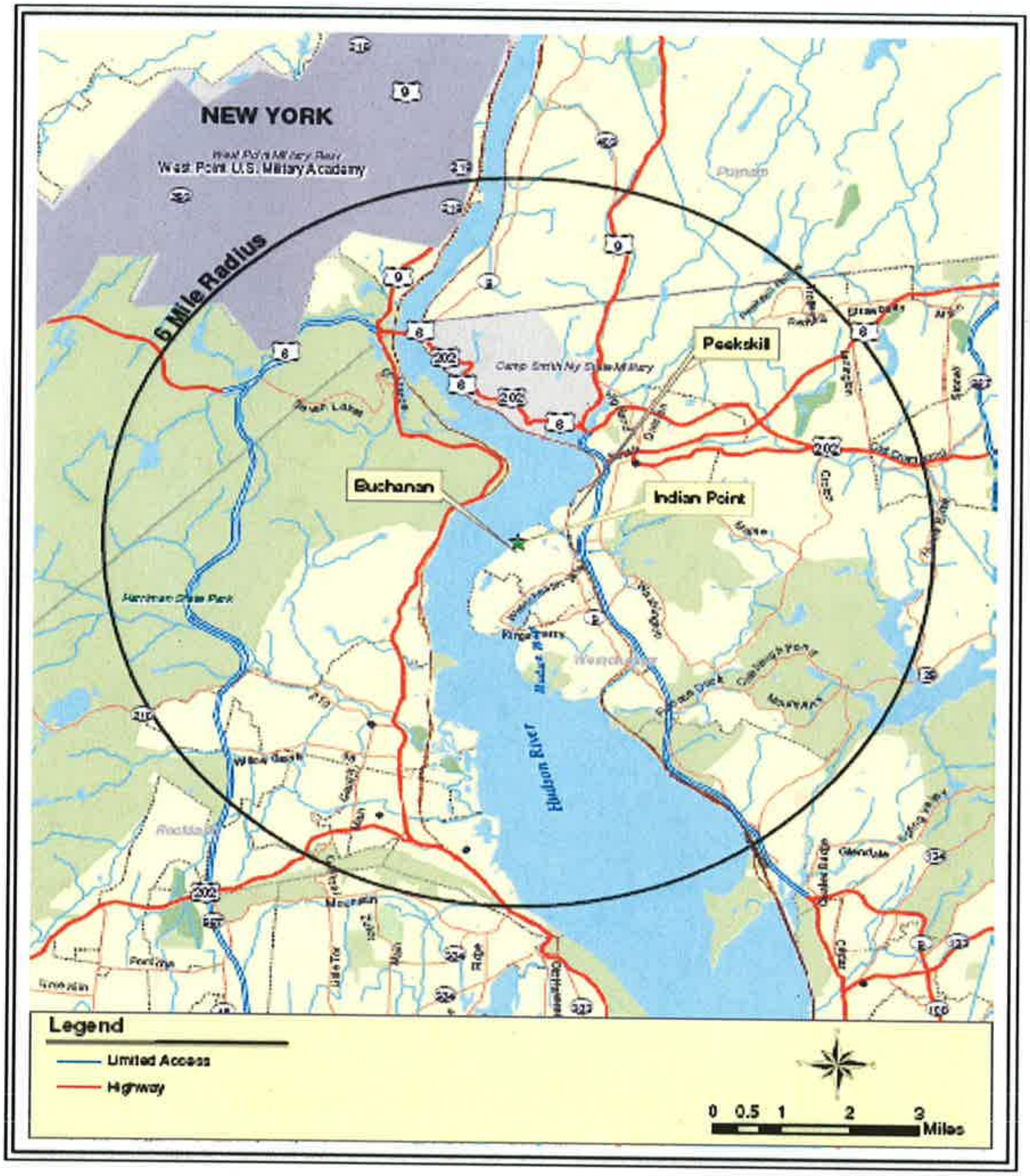
Wilber, Dara H. and Douglas C. Clarke. 2001. Biological Effects of Suspended Sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Woodland, R. J. 2005. Age, growth, and recruitment of Hudson River shortnose sturgeon (Acipenser brevirostrum). Master's thesis. University of Maryland, College Park.

Woodland, R.J. and D. H. Secor. 2007. Year-class strength and recovery of endangered shortnose sturgeon in the Hudson River, New York. Transaction of the American Fisheries Society 136:72-81.

Ziegeweid, J.R., C.A. Jennings, and D.L. Peterson. 2008a. Thermal maxima for juvenile shortnose sturgeon acclimated to different temperatures. Environmental Biology of Fish 3: 299-307.

Ziegeweid, J.R., C.A. Jennings, D.L. Peterson and M.C. Black. 2008b. Effects of salinity, temperature, and weight on the survival of young-of-year shortnose sturgeon. Transactions of the American Fisheries Society 137:1490-1499.

Figure 1

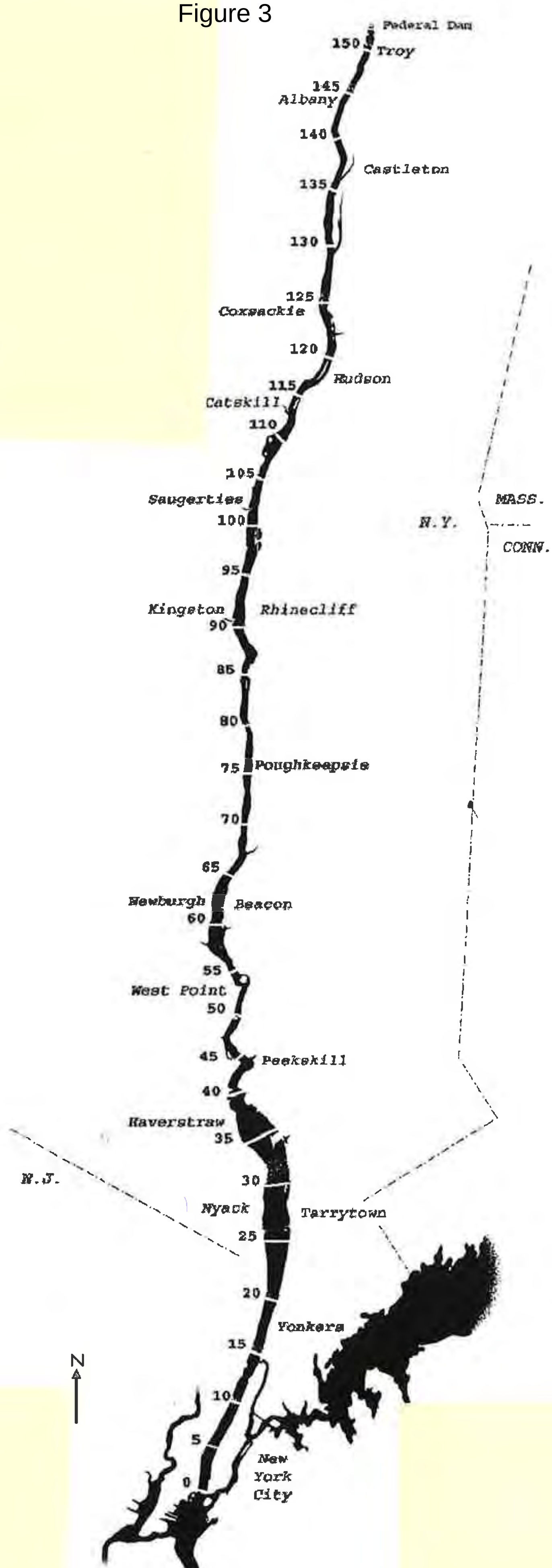


Location of Indian Point, View 1

Figure 2

Location of Indian Point, View 2

Figure 3



Hudson River Miles
p. 80

APPENDIX II

Incident Report Sturgeon Take – Indian Point

Photographs should be taken and the following information should be collected from all sturgeon (alive and dead) found in association with the Indian Point intakes. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name:____
Reporter's full name:____

Species Identification :____

Site of Impingement (Unit 2 or 3, CWS or DWS, Bay #, etc.):_________________________________

Date animal observed:________________ Time animal observed: ________________________
Date animal collected:________________ Time animal collected:_________________________

Environmental conditions at time of observation (i.e., tidal stage, weather):
____
____

Date and time of last inspection of intakes:_____________________________________
Water temperature (°C) at site and time of observation:__________________________
Number of pumps operating at time of observation:____________________________________
Average percent of power generating capacity achieved per unit at time of observation:________
Average percent of power generating capacity achieved per unit over the 48 hours previous to observation:____

Sturgeon Information:
Species ____________________________________

Fork length (or total length) ______________________ Weight _______________________

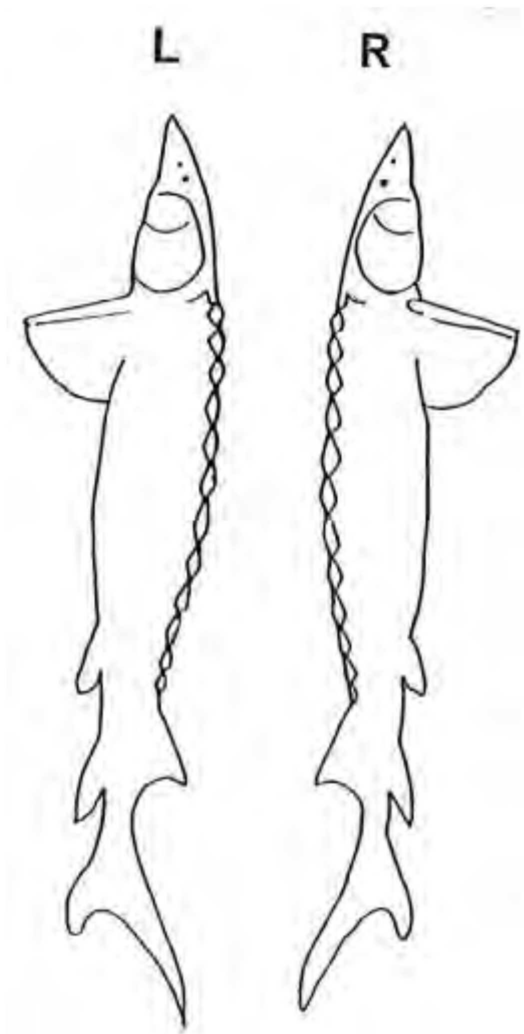
Condition of specimen/description of animal
____
____
____
____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish tagged: YES / NO *Please record all tag numbers.* Tag # _________________

Photograph attached: YES / NO
(please label *species, date, geographic site* and *vessel name* on back of photograph)

Appendix II, continued

Draw wounds, abnormalities, tag locations on diagram and briefly describe below



Description of fish condition:

STURGEON SALVAGE FORM

For use in documenting dead sturgeon in the wild under ESA permit no. 1614 (version 05-16-2012)

INVESTIGATORS'S CONTACT INFORMATION

Name: First ________________ Last ________________________

Agency Affiliation ________________ Email______________________

Address ____

____

Area code/Phone number ________________________________

UNIQUE IDENTIFIER (Assigned by NMFS)

DATE REPORTED:

Month ☐☐ Day☐☐ Year 20☐☐

DATE EXAMINED:

Month ☐☐ Day☐☐ Year 20☐☐

SPECIES: (check one)

☐ shortnose sturgeon
☐ Atlantic sturgeon
☐ Unidentified *Acipenser* species

Check "Unidentified" if uncertain . See reverse side of this form for aid in identification.

LOCATION FOUND: ☐Offshore (Atlantic or Gulf beach) ☐Inshore (bay, river, sound, inlet, etc)

River/Body of Water________________ City________________________ State ____

Descriptive location (be specific)____

____

____

Latitude ______________N (Dec. Degrees) Longitude ______________ W (Dec. Degrees)

CARCASS CONDITION at time examined: (check one)

☐ 1 = Fresh dead
☐ 2 = Moderately decomposed
☐ 3 = Severely decomposed
☐ 4 = Dried carcass
☐ 5 = Skeletal, scutes & cartilage

SEX:

☐ Undetermined
☐ Female ☐ Male

How was sex determined?

☐ Necropsy
☐ Eggs/milt present when pressed
☐ Borescope

MEASUREMENTS: **Circle unit**

Fork length ________ cm / in

Total length ________ cm / in

Length ☐ actual ☐ estimate

Mouth width (inside lips, see reverse side) ________ cm / in

Interorbital width (see reverse side) ________ cm / in

Weight ☐ actual ☐ estimate ________ kg / lb

TAGS PRESENT? Examined for external tags including fin clips? ☐ Yes ☐ No Scanned for PIT tags? ☐ Yes ☐ No

Tag #	Tag Type	Location of tag on carcass

CARCASS DISPOSITION: (check one or more)

☐1 = Left where found
☐2 = Buried
☐3 = Collected for necropsy/salvage
☐4 = Frozen for later examination
☐5 = Other (describe) ________________________

Carcass Necropsied?

☐Yes ☐No

Date Necropsied:____________

Necropsy Lead:

____

PHOTODOCUMENTATION:

Photos/vide taken? ☐ Yes ☐ No

Disposition of Photos/Video:__________

____

____

SAMPLES COLLECTED? ☐ Yes ☐ No

Sample	How preserved	Disposition (person, affiliation, use)

Comments:

____

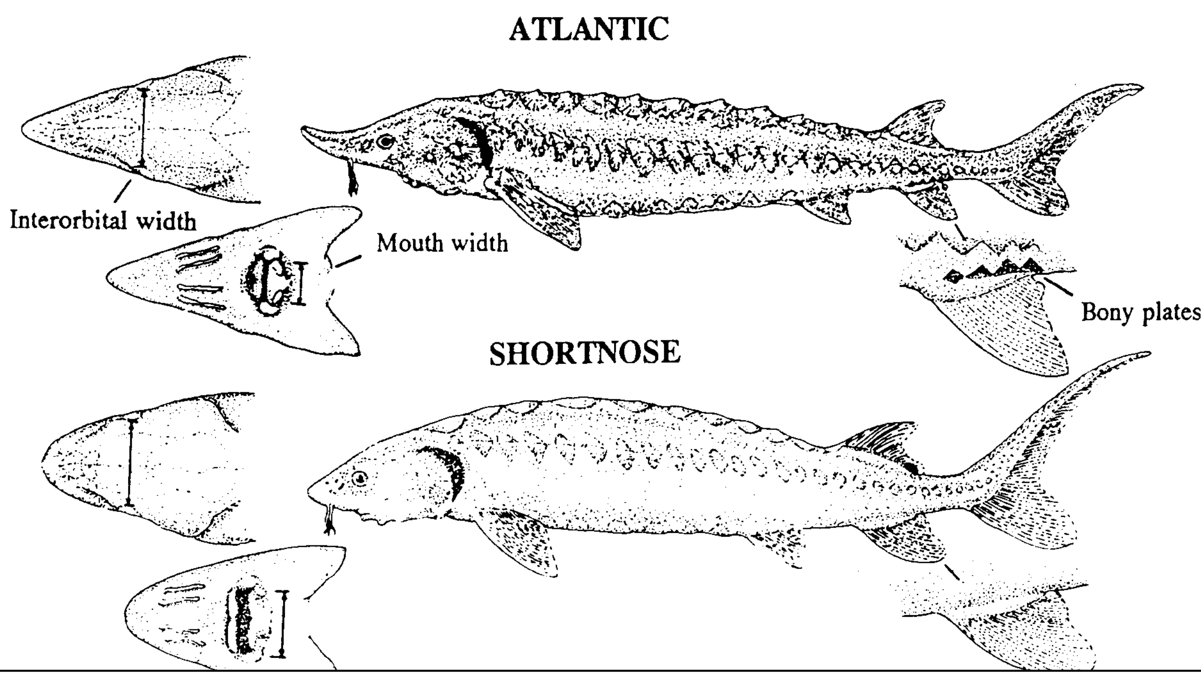
____

____

Distinguishing Characteristics of Atlantic and Shortnose Sturgeon (version 07-20-2009)

Characteristic	Atlantic Sturgeon, *Acipenser oxyrinchus*	Shortnose Sturgeon, *Acipenser brevirostrum*
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004



Describe any wounds / abnormalities (note tar or oil, gear or debris entanglement, propeller damage, etc.). Please note if no wounds / abnormalities are found.

____

____

____

____

____

Data Access Policy: Upon written request, information submitted to National Marine Fisheries Service (NOAA Fisheries) on this form will be released to the requestor provided that the requestor credit the collector of the information and NOAA Fisheries. NOAA Fisheries will notify the collector that these data have been requested and the intent of their use.

Submit completed forms (within 30 days of date of investigation) to: **Northeast Region Contacts** – Shortnose Sturgeon Recovery Coordinator (Jessica Pruden, Jessica.Pruden@noaa.gov, 978-282-8482) or Atlantic Sturgeon Recovery Coordinator (Lynn Lankshear, Lynn.Lankshear@noaa.gov, 978-282-8473); **Southeast Region Contacts**- Shortnose Sturgeon Recovery Coordinator (Stephania Bolden, Stephania.Bolden@noaa.gov, 727-824-5312) or Atlantic Sturgeon Recovery Coordinator (Kelly Shotts, Kelly.Shotts@noaa.gov, 727-551-5603).

APPENDIX IV

Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

1. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

Sending of Sample

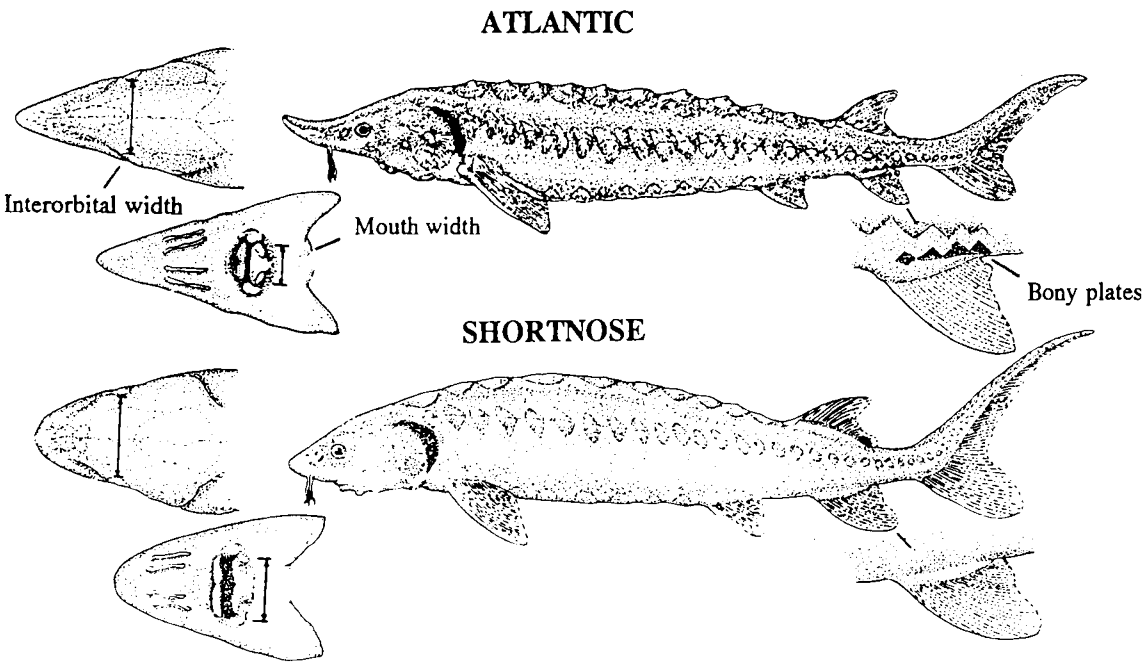
1. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547

   a. Prior to sending the sample, contact Russ Bohl at NMFS Northeast Regional Office (978-282-8493) to report that a sample is being sent and to discuss proper shipping procedures.

APPENDIX V

Identification Key for Sturgeon Found in Northeast U.S. Waters



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

Characteristic	Atlantic Sturgeon, *Acipenser oxyrinchus*	Shortnose Sturgeon, *Acipenser brevirostrum*
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004

Riverkeeper Amended Contention RK-EC-8A:

Attachment 5

RIVERKEEPER®
NY's clean water advocate

November 23, 2012

VIA U.S. MAIL AND ELECTRONIC MAIL

John K. Bullard
Regional Administrator
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
john.bullard@noaa.gov

Julie Crocker
Fisheries Biologist
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
julie.crocker@noaa.gov

Julie Williams
Attorney-Advisor
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
julie.williams@noaa.gov

Re: NMFS' 10/26/12 Draft Biological Opinion for Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252

Dear Ms. Kurkul, Ms. Crocker, & Ms. Williams:

Please accept the following comments on behalf of Riverkeeper, Inc. ("Riverkeeper") regarding National Marine Fisheries Service's ("NMFS") draft Biological Opinion ("draft BiOp") on the effects of the proposed continued operation of Indian Point Nuclear Generating Station ("Indian Point") Units 2 and 3 on endangered aquatic resources in the significant and historic Hudson River, dated October 26, 2012. While initial Endangered Species Act ("ESA") § 7 consultations regarding the proposed relicensing of Indian Point commenced in December 2010, considered the impacts of the operation of Indian Point on endangered shortnose sturgeon, and resulted in the issuance of a final Biological Opinion on October 14, 2011, formal consultation was reinitiated in May 2012 in light of the recent listing of Atlantic sturgeon as endangered on February 6, 2012. NMFS' new draft BiOp considers the impact of Indian Point on the Atlantic sturgeon, which occur in the Hudson River and are known to be affected by the operation of the plant, and, when finalized, will amend and supersede the agency's previous final BiOp relating to this matter.

Riverkeeper is a non-profit environmental watchdog organization that is committed to the protection of the aquatic ecology of the Hudson River, including endangered shortnose sturgeon and Atlantic sturgeon that reside in the river. To this end, Riverkeeper has historically been engaged in advocacy activities and legal actions involving Indian Point, and, as you are likely aware, is currently a party to the Indian Point operating license renewal proceeding pending before the U.S. Nuclear Regulatory Commission ("NRC"), the Indian Point State Pollutant Discharge Elimination System ("SPDES") permit renewal proceeding, and the Indian Point Clean Water Act ("CWA") § 401 Water Quality Certification ("WQC") appeal proceeding, all of which implicate and involve endangered species issues. Moreover, Riverkeeper retains and regularly consults with the renowned expert fisheries biologists of Pisces Conservation Ltd., on issues pertaining to the aquatic ecology of the Hudson River, and impacts of power plant cooling water intake structures thereto. Riverkeeper is, therefore, well situated to provide feedback on the draft BiOp. Furthermore, consideration of Riverkeeper's comments on NMFS' draft BiOp is both necessary and appropriate pursuant to basic tenets of fairness, due process, and the Federal government's commitment to openness, transparency, and public participation.[1] Notably, during NRC and NMFS' initial ESA § 7 consultation relating to the proposed relicensing of Indian Point, upon Riverkeeper's request, NMFS provided a copy of the draft BiOp, and Riverkeeper greatly appreciated the opportunity to review it and provide NMFS with relevant and important comments.[2] Riverkeeper thanks NMFS in advance for once again accepting and considering the comments submitted herein prior to any issuance of a final Biological Opinion ("final BiOp").

In particular, Riverkeeper respectfully submits the following comments and concerns relating to NMFS' new draft BiOp:

The Usefulness of Issuing a Final BiOp at this Time

As discussed in Riverkeeper's comments on NMFS' previous draft BiOp, Riverkeeper continues to question the appropriateness and efficacy of issuing a final BiOp at this time, in light of the uncertain status of ongoing State legal proceedings involving Indian Point.

---

[1] The opportunity to review and comment on the draft BiOp would facilitate Riverkeeper's ability to meaningfully participate in the aforementioned ongoing legal proceedings involving Indian Point and to act as a public advocate, as well as foster an open process that Federal agencies are obligated to strive for. Moreover, given that Riverkeeper's position in various Indian Point proceedings is adverse to that of the owner of Indian Point, Entergy Nuclear Operations, Inc. ("Entergy"), and the NRC, it is patently unfair to allow a one-sided external review of the draft BiOp by only Entergy and the NRC.

[2] *See* Letter from D. Brancato (Riverkeeper) to P. Kurkul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011). Indeed, Riverkeeper's comments raised issues that NMFS considered (albeit, not entirely) prior to finalizing its BiOp concerning shortnose sturgeon, including whether accidental radiological leaks from Indian Point had impacted the endangered species in the Hudson River as well as the impact of the Indian Point Unit 1 cooling water intake on shortnose sturgeon – issues for which NMFS' initial draft BiOp was completely silent. *See id.* at 7-9; *see generally* Endangered Species Act Section 7 Consultation DRAFT Biological Opinion - Relicensing - Indian Point Nuclear Generating Station, F/NER/2009/00619; endangered Species Act Section 7 Consultation Biological Opinion - Relicensing - Indian Point Nuclear Generating Station, F/NER/2009t00619, at 49-51, 62.

During NMFS' earlier consultations, NMFS asked NRC to consider withdrawing its request for ESA § 7 consultation until the uncertainties related to the continued operations of Indian Point were resolved.[3] However, per NRC's request, NMFS "completed consultation, considering effects of the proposed action, as defined by NRC staff in the FEIS and BA,"[4] i.e., in relation to existing operations of the plant pursuant to 1987 SPDES permits. NMFS' new, October 26, 2012 draft BiOp take the same approach: while legal proceedings that will determine what new technology will be required to modify the operation of Indian Point's cooling water intake structures remain ongoing, NMFS again only considered "the effects of the operation of IP2 and IP3 pursuant to the . . . [1987] SPDES permits issued by NYDEC that are already in effect" since "NRC requested consultation on the operation of the facilities under the . . . existing [1987] SPDES permits, even though a new SPDES permit might be issued in the future."[5] Thus, while NMFS recognized that the implementation of technology that Entergy has proposed, cylindrical wedge wire screens, "will affect shortnose and/or Atlantic sturgeon in a manner and to a degree that is very different from the effects"[6] of existing operations, the draft BiOp once again only narrowly considers impacts of the current operations of the plant on endangered species in the Hudson River.

Riverkeeper continues to question the utility of the instant ESA § 7 consultation process. To begin with, because NYDEC has unequivocally denied Entergy a necessary CWA § 401 WQC, it is not clear that Indian Point will even continue to operate, in which case §7 consultation regarding the impact of 20 additional years of operating the plant on endangered species would be unnecessary. Without a new, valid CWA § 401 WQC, Indian Point cannot continue to operate.[7] While NYSDEC's determination to deny Entergy this necessary certification was definitive, and made within the statutory one-year timeframe contemplated by the CWA, Entergy chose to avail itself of an optional hearing process on the decision, and that process is currently ongoing. The likelihood that Indian Point may not continue to operate in the absence of a new WQC renders the usefulness of the instant ESA § 7 consultation process questionable.

Moreover, NMFS' analysis in the draft BiOp considering only *existing* operations pursuant to a 25-year old, outdated, administratively extended SPDES permit, is less than useful. The "current" SPDES permit is presently the subject of a renewal proceeding that will result in the modification of the current permit (since it will require the implementation of the best technology available for minimizing the adverse environmental impacts caused by the current operation of Indian Point's environmentally destructive once-through-cooling water intakes). The analysis and determinations required in NMFS' BiOp necessarily hinge and depend upon the

---

[3] *See* Letter from P. Kurkul (Regional Administrator, NMFS) to D. Wrona (Branch Chief, NRC), Re: Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Oct. 14, 2011), at 1.

[4] *Id.*

[5] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 7, 11.

[6] *Id.* at 11.

[7] *See generally* Letter from D. Brancato (Riverkeeper) to NRC Commissioners, Re: Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-247-LR 50-286-LR (July 26, 2012), NRC ADAMS Accession No. ML12208A392.

outcome of that proceeding. It is simply unhelpful (as well as a waste of resources) to issue a final BiOp before the final outcome of the SPDES permit renewal proceeding is known.

The eventual outcomes of the ongoing State proceedings will determine if and how Indian Point might continue to operate, and, thus, more precisely, how the plant would impact endangered species in the Hudson River. NRC's continued request for § 7 consultation regarding a "proposed action" defined as the operation of Indian Point for 20 additional years pursuant to its *existing* (i.e., 1987 administratively extended) SPDES permit remains inappropriate and largely ineffective. As such, Riverkeeper once again opines that issuing a final BiOp at this time that is based on completely inaccurate and irrelevant assumptions is neither appropriate nor useful.

It is advisable and necessary for NRC to either withdraw and hold in abeyance its request for §7 consultation pending the outcome of the State proceedings, *or*, request §7 consultation for a "proposed action" that includes and fully accounts for the reasonably foreseeable differing outcomes of these proceedings, and which will result in a thorough analysis of the respective impacts of such differing outcomes. The State proceedings are indisputably at a point where reasonably foreseeable outcomes are discernible; the likely outcomes of the State proceedings are as follows: (1) Indian Point will no longer continue to operate, (2) Entergy will install and operate a closed-cycle cooling system and potentially various other measures related to the water intakes at Indian Point, or (3) Indian Point will continue to operate for 20 years with a once-through cooling water system and cylindrical wedge wire screens.[8]

For example, Entergy's proposal that Indian Point be allowed to continue to operate with the installation of cylindrical wedge wire screens,[9] clearly requires additional analysis, as such screens would undoubtedly impact the benthic environment and shortnose and Atlantic sturgeon in the Hudson River: these screens would require an enormous set of underwater structures -- 144 screens each of 72 inches in diameter, made of a metal alloy with toxicity implications -- that would rest on the floor of the river, where, as NMFS' draft BiOp discusses at length, sturgeon are present for foraging, migrating, avoiding unsuitable thermal temperatures occurring at higher elevations, etc.[10]

---

[8] NRC has and may continue to argue that it would not be appropriate to speculate as to the outcome of the pending State proceedings, especially since, as NRC has repeatedly acknowledged, it does not have jurisdiction over issues related to Indian Point's state water permits. *See* In re Entergy Nuclear Operations, Inc. (Indian Point, Units 2 and 3), 68 NRC 43, *156-57 (2008) ("NRC is prohibited from determining whether nuclear facilities are in compliance with CWA limitations, assessing discharge limitations, or imposing additional alternatives to further minimize impacts on aquatic ecology that are subject to the CWA. . . [T]he NRC has promulgated regulations, specifically 10 C.F.R. § 51.53(c)(3)(ii)(B), to implement these specific CWA requirements that help assure that the Commission does not second-guess the conclusions in CWA-equivalent state permits, or impose its own effluent limitations . . . . It would be futile for the Board to review any of the CWA determinations, given that it is not possible for the Commission to implement any changes that might be deemed appropriate"). However, asking NMFS to perform a relevant analysis (as opposed to a completely irrelevant and useless one) would clearly not conflict with NRC's lack of authority to substantively opine on Indian Point's CWA-related permits. Moreover, as stated above, the State proceedings are clearly at a point where reasonably foreseeable outcomes are apparent.

[9] Riverkeeper maintains that such an outcome would not be in compliance with federal and state law.

[10] Notably, in the state CWA § 401 and SPDES proceedings, Entergy has failed to provide any analysis of the adverse environmental impacts associated with the construction and operation of a 144-screen array in the Hudson River.

In any event, it is axiomatic that NMFS' *relevant* analysis and conclusions must be taken into account in the Indian Point operating license renewal proceeding, and in NRC's ultimate licensing decision. The relicensing proceeding, from which the ESA §7 consultation obligation stems, and associated review processes are occurring now. The ESA §7 consultation is a critical aspect to these reviews. In particular, NMFS' analysis is a critical and necessary component of the National Environmental Policy Act ("NEPA") process in the Indian Point license renewal proceeding. Indeed, the Atomic Safety and Licensing Board ("ASLB") presiding over the Indian Point relicensing case had ruled that "NMFS's BiOp will aid the agency [i.e., NRC] in making its licensing decision in this [relicensing] proceeding. Without receipt and consideration of that input from NMFS, the NRC Staff arguably has not taken the requisite hard look at this issue."[11] As a result, the final environmental impact statement that NRC Staff has already issued in the Indian Point license renewal proceeding, in conjunction with a pending supplement to the final environmental impact statement that has yet to be finalized, will be inadequate without review and consideration of a final BiOp that analyzes all *relevant* issues.

Therefore, whether or not NRC's §7 consultation request is withdrawn until the State proceedings conclude, or whether or not NRC redefines the relevant "proposed action" to ensure an accurate and adequate analysis by NMFS, it is clear that NRC must factor NMFS' ultimate analysis and conclusions into the environmental review process concerning the proposed license renewal of Indian Point, and in the final decision regarding whether to grant renewed licenses for the plant.[12]

---

[11] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3, Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (Ruling on Pending Motions for Leave to File New and Amended Contentions (July 6, 2011), at 69-70.

[12] In the event NRC does not choose either of these options, and proceeds with consultation under the faulty assumption regarding how Indian Point would continue to operate, as NMFS has made clear, re-initiation of consultation will be necessary once the outcome of the State proceedings is known, to account for the inevitable new information and circumstances that will arise. Under such a scenario, NRC, at that time would be obliged to consider NMFS' new/additional analysis and conclusions in the Federal environmental review process concerning the proposed license renewal of Indian Point, and in the final decision regarding whether to grant renewed operating licenses to the facility. For example, as discussed above, should Entergy's proposal to implement cylindrical wedge wire screens at Indian Point ultimately prevail, a new assessment by NMFS would clearly be necessary, as such screens would impact shortnose and Atlantic sturgeon in the Hudson River, which will have to be accounted for in the Federal relicensing case.

Notably, given NRC's noted lack of jurisdiction over CWA-related issues, NRC may choose to not await the outcome of the Indian Point SPDES permit renewal proceeding before attempting to conclude the license renewal proceeding; additionally, while NRC may not issue renewed operating licenses for Indian Point unless the plant receives a valid CWA § 401 WQC, this does not prevent NRC from attempting to finalize and conclude all otherwise required analyses and review processes, or from reaching a determination about the appropriateness of relicensing Indian Point from a safety and environmental perspective, which could be executed in the event a valid §401 certification is issued. However, under no circumstances would it be legal for NRC to in any way preclude consideration of the ESA §7 consultation process in the relicensing proceeding: consideration of NMFS's assessment on endangered species impacts is necessary pursuant to NEPA. *See generally*, Riverkeeper, Inc. Consolidated Motion for Leave to File a New Contention and New Contention Concerning NRC Staff's Final Supplemental Environmental Impact Statement (Feb. 3, 2011), *accessible at*, http://www.nrc.gov/reading-rm/adams.html#web-based-adams, ADAMS Accession No. ML110410362 (proffering a legal contention asserting the insufficiency of NRC's final environmental impact statement for failure to account for the ESA §7 consultation process, which was later deemed a valid and adjudicable issue by presiding ASLB). Therefore, when, in the future, In the event that NRC does not either withdraw and hold in abeyance its request for ESA §7 consultation pending the outcome of the State proceedings, or, request ESA §7 consultation for a redefined "proposed action" to ensure an accurate and adequate analysis by NMFS, and NMFS intends to issue a Final BiOp, Riverkeeper submits the following comments on the new draft BiOp.[13]

NMFS' Incidental Take Statement

NMFS' draft BiOp includes an Incidental Take Statement ("ITS") which exempts the take of 562 shortnose sturgeon impinged by Indian Point Units 1, 2, or 3 intakes throughout the proposed relicensing period, and 219 New York Bight ("NYB") Distinct Population Segment ("DPS") Atlantic sturgeon impinged by Indian Point Units 1, 2, or 3 intakes throughout the proposed relicensing period.[14] NMFS concludes that such losses of sturgeon caused by Indian Point over a proposed 20 period of extended operation are not significant.

Riverkeeper does not agree that such losses are appropriate or acceptable. Notably, sturgeon are an aspect of the designated use assigned to the Hudson River pursuant to the CWA; this designated use dictates that the Hudson River "shall be suitable for fish, shellfish, and wildlife propagation and survival."[15] Moreover, the historical existing use of the Hudson River as a sturgeon fishery is an established fact. The degree and appropriateness of the impact of Indian Point on endangered sturgeon in the Hudson River must be considered in view of these circumstances.[16]

In addition, due to the slow maturation process and intermittent spawning of shortnose and Atlantic sturgeon, (which NMFS' draft BiOp recognizes[17]), *any* impacts on this species may

NMFS assesses new, previously unanalyzed information arising out of the ultimate decisions in the now pending State proceedings, this will necessitate a supplemental review and analysis by the NRC in the license renewal proceeding pursuant to NEPA.

[13] Riverkeeper does not repeat, but incorporates by reference the comments previously submitted related to shortnose sturgeon (Letter from D. Brancato (Riverkeeper) to P. Kukul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011)), to the extent they were not adequately addressed or considered in NMFS' previous final BiOp, and, in turn, NMFS' current draft BiOp.

[14] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 119.

[15] 6 NYCRR § 864.6; 6 NYCRR § 701.11.

[16] *See generally* Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Petition for Full Party Status and Adjudicatory Hearing, (July 10, 2010), *accessible at*, http://www.riverkeeper.org/wp-content/uploads/2010/07/RK-NRDC-SH-Petition-for-Full-Party-Status-Indian-Point-401-WQC-scanned.pdf (last visited Nov. 20, 2012) at 31-34. Riverkeeper appreciates and understands the difference between the ESA and the CWA, but respectfully submits that the protections afforded to endangered resources pursuant to the CWA are relevant and important.

[17] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 15, 24, 26.

have noticeable affects, and it is critical that such impacts are kept to a minimum. Fisheries Biologist Dr. Peter Henderson of Pisces Conservation Ltd has provided his expert opinion that these numbers are appreciable, and for "endangered long-lived species," "cannot be considered trivial."[18]

In relation to shortnose sturgeon, as Dr. Henderson explains, the special significance of the Hudson River to the species warrants particular protection.[19] Dr. Henderson points out that favorable recruitment of shortnose sturgeon may not persist given potential climate change impacts and explains the lack of scientific support for the claim that the population of shortnose sturgeon in the Hudson River is stable and at carrying capacity; Dr. Henderson further disagrees with NMFS' conclusion that the proposed relicensing of Indian Point will not necessarily affect the population of shortnose sturgeon in the Hudson River, since Indian Point will undoubtedly contribute to the reduction of the likelihood that individual sturgeons will reach old age; Moreover, Dr. Henderson explains that the lack of information on the range of mortality rates attributable to man and their combined impact on the Hudson River population of shortnose sturgeon is unclear.[20]

In relation to Atlantic sturgeon, Dr. Henderson explains that fate of Atlantic sturgeon in the Hudson River is important since recent spawning information is only known from the Hudson and Delaware rivers.[21] Dr. Henderson does not agree that the impingement of a small proportion of the juvenile population of Atlantic sturgeon will not necessarily jeopardize the continued existence of the species, since impingement mortality and habitat degradation hinder recovery.[22] Dr. Henderson explains that the indication that the population of Atlantic sturgeon is increasing is poor and does not properly ground NMFS' conclusion that the losses attributable to Indian Point are not significant, as well as the fact that, similar to shortnose sturgeon, combined effects related to Atlantic sturgeon are not well-quantified.[23]

Dr. Henderson has further explained to Riverkeeper that it is important to distinguish the impacts of power plant operations from other impacts such as fishing. For example, while there is a tendency to view power stations as another exploiter of a population like fishermen, this is not the case because if the population has a couple of poor recruitment years, it is possible for environmental managers to reduce the hunting take. That is, fishing activity can be actively managed and a response made quickly if a population gets into trouble. On the other hand, nuclear power plants, once given permission to operate, will continue to operate and do harm for many years. It is effectively impossible for the license of such a plant to be revoked or for the output and water use of a plant to be quickly changed because a population is getting into trouble. To the contrary, they are inflexible, and, as a result, cannot contribute to population management. Dr. Henderson has advised Riverkeeper that over long periods of 10-25 years, this

[18] Attachment 1 – Memorandum from Pisces Conservation Ltd, "Sturgeon and Indian Point," (Nov. 21, 2012) at 1.

[19] *Id.* at 1-2.

[20] *Id.*

[21] *Id.* at 2.

[22] *Id.*

[23] *Id.*

inflexibility is likely to become important and harmful as all populations will occasionally have hard times. Because of the particularly inflexible and detrimental impacts of power plants, care and caution must be taken over decisions involving such plants.

The expert assessment of Pisces Conservation Ltd clearly reveals that NMFS' conclusions exempting the take of endangered sturgeon in the Hudson River are not adequately founded.

In addition, NMFS' conclusions regarding the prospective impacts to endangered sturgeon from the ongoing, i.e., future, operation of Indian Point are not well-founded due to the fact that they are based on data that was collected over twenty years ago. That is, NMFS drew conclusions without any knowledge about the current *actual* impacts of Indian Point. As a result, NMFS' findings are arbitrary and inherently unreliable. As Dr. Henderson explains, the populations of both shortnose and Atlantic sturgeon have changed since data was collected, as well as plant operations and technical specifications; a notable example is that no sampling has been undertaken since Ristroph screens were installed, resulting in no relevant data on sturgeon survival.[24]

NMFS' Assessment of the Cumulative Impacts to Atlantic Sturgeon[25]

NMFS recognizes that Indian Point has had and (with the continued use of the existing once-through cooling water intake structure) will continue to have adverse impingement impacts on endangered Atlantic sturgeon in the Hudson River.[26] NMFS has concluded the loss of Atlantic sturgeon from the ongoing (existing) operation of Indian Point would "not appreciably reduce the likelihood that the NYB DPS of Atlantic Sturgeon will survive in the wild."[27]

However, it remains questionable whether NMFS has adequately assessed the losses of Atlantic sturgeon in the Hudson River in view of all Atlantic sturgeon entrainment- and impingement-related losses over *all* intakes of all the power plants in the Hudson River and other relevant waters. All of these intakes taken together are authorized to withdraw trillions of gallons of water every year.[28] While NMFS' draft BiOp makes cursory reference to the existence of other

---

[24] *Id.* at 1-2.

[25] Riverkeeper submitted concerns related to the inadequate consideration of cumulative impacts on shortnose sturgeon, which are incorporated by reference into the instant comments. *See* Letter from D. Brancato (Riverkeeper) to P. Kukul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011), at 5-7; *see also* Attachment 1 – Memorandum from Pisces Conservation Ltd, "Sturgeon and Indian Point," (Nov. 21, 2012) at 1-2.

[26] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 14.

[27] *Id.* at 116.

[28] *See, e.g.,* NYSDEC Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System Permits for the Roseton 1 & 2, Bowline 1 & 2 and Indian Point 2 & 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties, Hudson River Power Plants FEIS (June 25, 2003) (hereinafter "2003 DEC Hudson River Power Plants FEIS"), at 71 (Responses to Comments), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP6.pdf (indicating in 2003 that "[t]he sheer volumes of water necessary to meet the HRSA [Hudson River Settlement Agreement] plants' cooling requirements are enormous. Together, Indian Point, Roseton, and Bowline are authorized to withdraw *1.69 trillion* gallons per year for cooling water . . . ") (emphasis added).

impingement related impacts to Atlantic sturgeon in the Hudson River, NMFS presents no analysis of the combined, total cumulative impacts to shortnose sturgeon, and no assessment of whether, *in light of such overall impacts*, the losses caused by Indian Point would appreciably affect the species in the river. As Dr. Henderson of Pisces Conservation Ltd has previously advised, a BiOp without such an analysis is deficient.[29]

In particular, if Indian Point might allegedly kill 219 individual Atlantic sturgeon over the proposed 20 year license renewal period for Indian Point, such losses must be considered as part of an overall loss from *all* water extraction activities. That is, NMFS must assess what losses all power plants combined inflict on Atlantic sturgeon.[30] NMFS' draft BiOp reveals an inadequate sense of the spatial extent of the Hudson River Atlantic sturgeon population or threats facing it.[31] There is a dearth of analysis of the cumulative impacts over the geographical range of this population. In addition, a cumulative impact assessment must also appropriately consider the combined impacts of other projects that affect endangered sturgeon in the Hudson River and NYB DPS, including the Tappan Zee Bridge Replacement Project; as NMFS' draft BiOp indicates, this transportation infrastructure project will result in impacts to endangered sturgeon.[32]

An adequate cumulative impact analysis is necessary in order to arrive at any ultimate conclusions regarding the impact of Indian Point on this endangered species, and, if appropriate, to determine further reasonable and prudent measures necessary to minimize impacts to Atlantic sturgeon. For example, if the combined impacts to Atlantic sturgeon are significant, then each plant must reduce its impact, even if each is not responsible for an appreciable number. NMFS cannot deem the losses caused by Indian Point acceptable in a vacuum, i.e., without putting such

[29] *See* Letter from D. Brancato (Riverkeeper) to P. Kukul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011),at 5-7; *see also* 2003 DEC Hudson River Power Plants FEIS, at 16, *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP3.pdf ("In addition to impingement and entrainment losses associated with the operation of CWIS, *another concern is the cumulative degradation* of the aquatic environment as a result of: (1) multiple intake structures operating in the same watershed or in the same or nearby reaches; and (2) intakes located within or adjacent to an impaired waterbody. . . . [T]here is concern about the effects of multiple intakes on fishery stocks") (emphasis added); *see also id.* at 54 (Responses to Public Comments), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP5.pdf ("The actual draw-down [i.e., "[t]he direct reduction of the quantity of organisms within the water column by water intakes"] is likely even greater because the three HRSA generating plants (combined with other facilities in the same river reaches) *act cumulatively on the entire aquatic community*") (emphasis added).

[30] It is well known that other power plants impinge and entrain sturgeon, which the draft BiOp acknowledges and describes in part. *See also* NMFS Sturgeon Recovery Plan, at 55 ("The operation of power plants in the upper portions of rivers has the greatest potential for directly affecting sturgeon populations because of the increased incidence of entraining younger and more vulnerable life stages. Documented mortalities of sturgeon have occurred in the Delaware, Hudson, Connecticut, Savannah and Santee rivers. Between 1969 and 1979, 39 shortnose sturgeon were impinged at power plants in the Hudson River (Hoff and Klauda 1979).").

[31] For example, does the population extend into Long Island Sound and other areas of adjacent coast where it is impacted by other intakes?

[32] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12) at 44.

losses into proper context, and determining whether such losses are significant in light of all other relevant impacts to the species.

Similarly, while NMFS has concluded that the thermal plume at Indian Point is not likely to negatively affect Atlantic sturgeon in the vicinity of the plant, NMFS has failed to adequately assess the cumulative impacts of power plant thermal plumes on Atlantic sturgeon.[33] While it may be correct that Atlantic sturgeon will avoid water that is too warm for them, if there are numerous regions with plumes that are being avoided, NMFS must assess what total loss of habitat may be occurring and whether such loss is appreciable for the species in the Hudson River. This is especially important in light of global climate change, which NMFS recognizes will cause the water temperature of the Hudson River to rise over time. NMFS must view the thermal impacts of Indian Point with regard for the broader range of thermal impacts faced (and to be faced) by the species in the river.[34]

NMFS' overall conclusion is that the continued operation of Indian Point during Entergy's proposed 20 year period of extended operation "is not likely to jeopardize the continued existence of" NYB DPS of Atlantic sturgeon.[35] However, given NMFS' failure to properly view the losses of Atlantic sturgeon caused by the operation of Indian Point in light of total impacts to this species in the Hudson River, these conclusions are, as yet, dubious.

NMFS' Failure to Adequately Consider Impacts of Radiological Releases from Indian Point on Endangered Sturgeon

In contrast to NMFS' previous draft BiOp (which omitted any mention, let alone discussion and analysis of radiological discharges from Indian Point), NMFS' new draft BiOp does include a discussion of the potential impact of radionuclides from Indian Point on endangered sturgeon in the Hudson River. However, NMFS' analysis is not adequate to resolve all concerns related to the potential effects on shortnose and Atlantic sturgeon caused by the regular release of radionuclides directly to the Hudson River from Indian Point, as well as the toxic radionuclide laden contamination plumes that underlie the site, which undeniably migrate and release to the Hudson River.

NMFS discusses Entergy's REMP program, as well as a one-time enhanced radiological monitoring study conducted in 2007 (i.e., 5 years ago), and based on this information, concludes that "while shortnose and Atlantic sturgeon may be exposed to radionuclides originating from

---

[33] Riverkeeper has offered comments on the illegality of NYSDEC's proposed issuance of a 75-acre mixing zone to allow the facility to discharge heated effluent to the Hudson and expects that issues related to thermal considerations will be advanced to adjudication.

[34] *See* 2003 DEC Hudson River Power Plants FEIS at 71 (Public Comment Summary), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP6.pdf (indicating in 2003 that "[t]ogether, Indian Point, Roseton, and Bowline are authorized to withdraw 1.69 trillion gallons per year for cooling water, and they discharge 220 trillion BTU of waste heat per year. The volume of once-through cooling water is raised between 15°F and 18°F, depending on the plant, or an average of 16.2°F"); *see also supra* Note 9 (discussing concerns relating to cumulative impacts to aquatic ecology of the Hudson River).

[35] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 117.

Indian Point . . . any exposure is not likely to be at levels that would affect the health or fitness of any individual shortnose or Atlantic sturgeon. . . . Thus, NMFS considers the effects to shortnose and Atlantic sturgeon from radionuclides to be insignificant and discountable."[36] However, NMFS' limited review does not warrant such definitive and sweeping conclusions.

To begin with, it is necessary to clarify that the radiological contamination at Indian Point is not simply the result of past spent fuel pool leaks, which NMFS' draft BiOp seems to imply. In fact, decades of leaks from a variety of components, including the Unit 1 and Unit 2 spent fuel pools, but also underground pipes and structures, and other components, has resulted in extensive plumes of contamination (which contain, *inter alia*, highly toxic strontium-90 and cesium-137, as well as tritium) in the groundwater beneath the Indian Point plant. It is undisputed that this contamination leaches through the bedrock beneath Indian Point, and discharges to the Hudson River.[37] Other critical overlooked and unmentioned facts are that active current radiological leaks occur, future additional leaks are highly likely, and that any such leaks at Indian Point will add to the existing contamination plumes.[38] Entergy's current "remediation" methodology is Monitored Natural Attenuation,[39] and, thus, this contamination will persist in the groundwater and continually be discharged to the Hudson River throughout the proposed period of extended operation, and beyond.

In light of these circumstances, NMFS' assessment of the potential impact of radiological releases from Indian Point on endangered species in the Hudson River in its draft BiOp is wanting. In particular, NMFS has failed to consider cumulative impacts on endangered species due to ongoing and future radiological releases from Indian Point *throughout* the proposed relicensing period. It is undisputed that past fish samples have showed elevated levels of radionuclides, and there is every reason to believe, absent any enhanced and regular fish sampling scheme, that because the groundwater contamination at Indian Point directly discharges to the Hudson River, it may impact fish in the river during the proposed relicensing terms. Even if endangered species in the Hudson River are being exposed to "small" levels of radionuclides, NMFS has demonstrably failed to conduct the assessment necessary to found the sweeping conclusion that any such impacts are "insignificant and discountable." Relying on a *one-time* study that was conducted 5-years ago for an apparent assurance that the radionuclides attributable to Indian Point will not impact endangered resources through 2035 belies logic and science. Moreover, NMFS' reliance on Entergy's REMP program, which involves a relatively limited set of opportunistic sampling that does not involve sampling of bone, where Strontium-

---

[36] *Id.* at 102.

[37] *See* Groundwater Investigation Executive Summary (Indian Point Entergy Center, Buchanan, N.Y., Jan. 2008), at 1 ("The plumes ultimately discharge to the Hudson River to the West").

[38] *See generally*, Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Petition for Full Party Status and Adjudicatory Hearing, (July 10, 2010), *accessible at*, http://www.riverkeeper.org/wp-content/uploads/2010/07/RK-NRDC-SH-Petition-for-Full-Party-Status-Indian-Point-401-WQC-scanned.pdf (last visited Nov. 20, 2012), at 39-48; Post-Hearing Closing Brief of Intervenors Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Regarding Issue for Adjudication No. 3 – Radiological Materials (April 27, 2012), at 24-66.

[39] *See, e.g.*, GZA GeoEnvironmental, Inc., Hydrogeologic Site Investigation Report, Indian Point Energy Center (Jan. 7, 2008) ("The proposed remediation technology is source elimination/control . . . with subsequent Monitored Natural Attenuation, or MNA.")

90 is known to concentrate, is clearly inadequate to support an overall conclusion that radionuclides from Indian Point pose no danger to shortnose and Atlantic sturgeon in the Hudson River for the next 20+ years. Notably, Riverkeeper has questioned the legality of the accidental radiological releases from Indian Point to waters of NYS in State proceedings that are still pending. Those proceeding revealed Entergy's failure to demonstrate that radiological leaks will not adversely impact the aquatic ecology of the Hudson River, which includes endangered sturgeon species, during the proposed relicensing terms.[40]

The lack of adequate analysis by NMFS is particularly troubling given the known dangers of exposure to radioactive substances such as strontium-90 and tritium: Strontium-90 imitates calcium by concentrating in fish bones and shells of clams and blue crab. Clams are a major part of the diet of sturgeon found in the Hudson River. Riverkeeper, therefore, continues to be concerned that Hudson sturgeon are being exposed to elevated levels of this dangerous substance, opine that NMFS' assessment does not resolve these concerns.

In addition, Entergy has indicated that cesium contamination is present in Hudson River sediments in front of Indian Point and that this contamination is attributable in part to releases from Indian Point.[41] Entergy's plans to dredge such sediments in order to install cylindrical wedge wire screens on the river-bottom poses a clear risk to endangered sturgeon from radionuclides from Indian Point. Yet, NMFS has failed to consider such impacts. Notably, Entergy's lack of adequate information on the what levels of contaminants attributable to Indian Point are in the river sediments or how sediment discharges can and should be controlled[42] highlights the potential risks posed to endangered sturgeon species in the river that have not been accounted for.

NMFS' BiOp must properly analyze the potential effects of radiological releases and groundwater contamination at Indian Point on shortnose and Atlantic sturgeon. Assessing this issue is a critical aspect of NMFS' overall assessment of impacts to these endangered species, and should certainly be considered in terms of further necessary and appropriate reasonable and prudent measures that should be implemented at Indian Point. For example, appropriate measures include remediation and mitigation measures to assure that radiological contamination attributable to Indian Point does not discharge to the Hudson River in the first instance, which, according to representations from Entergy, is entirely possible.[43]

---

[40] *See generally* Post-Hearing Closing Brief of Intervenors Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Regarding Issue for Adjudication No. 3 – Radiological Materials (April 27, 2012).

[41] IPEC CWW Dredging Step 1 – Draft White Paper Postulated Contamination Characterization (Nov. 2011). Notably, Riverkeeper filed a motion to reopen the record in the State adjudicatory proceedings to allow meaningful consideration of the information in this report, which came to light after hearings on the relevant issue concluded, in relation to how radiological leaks at Indian Point have impacted, or will impact, the Hudson River. While this motion was denied, the time to appeal the denial is still ongoing; moreover, the State tribunal has indicated that concerns related to the sediment issue can appropriately be raised in the context of hearings related to Entergy's cylindrical wedge wire screen proposal.

[42] *See id*.

[43] In the Matter of: Entergy Nuclear Indian Point 2, LLC, and Entergy Indian Point 3, LLC, For a State Pollution Discharge Elimination System Permit Renewal and Modification, DEC No.: 3-5522-00011/00004, SPDES No.: NY-0004472; Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear

<u>NMFS' Failure to Assess all Reasonable and Prudent Measures</u>

NMFS concludes that potential losses of Atlantic sturgeon caused by Indian Point over a proposed 20 year period of extended operation are not significant, and therefore, exempts a certain level of impingement. As discussed above, NMFS' conclusions are, at a minimum, uncertain, given the extent of the take, and due to NMFS' failure to properly assess the cumulative impacts to sturgeon in the Hudson River. Moreover, Riverkeeper once again respectfully submits that, because of the slow maturation process and intermittent spawning of Atlantic sturgeon, (which NMFS' draft BiOp recognizes[44]), *any* impacts on this species may have noticeable affects, and that it is critical that impacts on Atlantic sturgeon are kept to a minimum.

In any event (that is, whether NMFS' overall conclusions are supportable or whether the impacts may be more significant than the draft BiOp concludes), due to the availability of a technology that would substantially reduce the impacts to Atlantic sturgeon caused by Indian Point, i.e., closed-cycle cooling,[45] Riverkeeper fails to understand why the draft BiOp does not assess the efficacy of this technology as a "reasonable and prudent measure"[46] to be implemented at the plant.

While Riverkeeper understands that the outcome of the NYDEC SPDES permit modification proceeding will ultimately determine whether closed-cycle cooling will be required at Indian Point, [47] there is no reason this should preclude NMFS from examining this technology, and

Operations, Inc. Joint Application for CWA § 401 Water Quality Certification, DEC App. Nos. 3-5522-00011/00030 (IP2), 3-5522-00105/00031, Transcript of Arbitration before Daniel P. O'Connell, ALJ, Maria E. Villa, ALJ, Reporter: Alan H. Brock, RDR, CRR, Farmer Arsenault Brock LLC (January 11, 2012, pages 3071-3344; January 23, 2012, pages 3895-4125), at 4041:2-6, 11-14, 4094:1-2, 18-21.

[44] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 24, 26.

[45] Closed-cycle cooling systems require only a small fraction of the water which is required by once-through cooling systems, and since aquatic mortality is directly related to the amount of water use, a retrofit to a closed-cycle cooling system results in substantial reductions in aquatic mortality. *See* DEC Fact Sheet, New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal With Modification, Indian Point Electric Generating Station, Buchanan, NY – November 2003, at Attachment B, p.3, *available at* http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf (last accessed Nov. 20, 2012) ("Closed-cycle cooling recirculates cooling water in a closed system that substantially reduces the need for taking cooling water from the River."); *see also, e.g.*, Network for New Energy Choices, *The Truth About Closed-Cycle Cooling* (2010), *available at,* http://www.newenergychoices.org/uploads/fishkill_truth.pdf (last accessed Nov. 20, 2012).

[46] *See* 50 C.F.R. § 402.02 ("*Reasonable and prudent measures* refer to those actions the Director believes necessary or appropriate to minimize the impacts, *i.e.*, amount or extent, of incidental take."); *see id.* § 402.14(g)(8) ("In formulating its biological opinion, . . . and any reasonable and prudent measures, the Service will use the best scientific and commercial data available. . ."); *see also id.* § 402.14(i)(ii) ("the Service will provide with the biological opinion a statement concerning incidental take that: . . . (ii) Specifies those reasonable and prudent measures that the Director considers necessary or appropriate to minimize such impact").

[47] As discussed at length above, in order for the consultation process to be meaningful and useful, NRC should request consultation regarding the reasonably foreseeable outcomes of the ongoing State proceedings, or, in the alternative, withdraw its request for consultation and initiate such consultation in the future after the State proceedings conclude. However, if NRC does not do this, and NMFS and NRC continue the consultation process

reaching independent conclusions about whether instituting this technology would be beneficial for endangered aquatic resources in the Hudson River.

Overall, NMFS' "Reasonable and Prudent Measures" fail to result in a net benefit to the endangered sturgeon populations in the Hudson River and NYB DPS. NMFS' "Reasonable and Prudent Measures" require monitoring of impingement, releasing any live sturgeon back to the river, performing necropsy's on any dead sturgeon, conducting genetic sampling of all impinged sturgeon, and reporting any sturgeon sightings near Indian Point.[48] While these measures are certainly important, altogether they fail to reduce the likely non-trivial impact Indian Point will have on endangered sturgeon in the Hudson River.

NMFS' Conservation Recommendations

Riverkeeper questions the efficacy and sufficiency of NMFS' "Conservation Recommendations" related to the impact of Indian Point on endangered sturgeon in the Hudson River. NMFS recommends that NRC ensure and/or require tissue analysis, impingement/entrainment/heat shock studies, thermal plume model studies, REMP samples of forage species, mortality studies, in-water assessments and abundance/distribution surveys in the Hudson River and Haverstraw Bay in particular, and studies to assess sturgeon interaction with Indian Point's thermal plume.[49]

To begin with, while these recommendations are important and will result in the existence of better information about the impact of Indian Point on endangered aquatic resources, as NMFS explains, such recommendations from NMFS to the NRC are "discretionary agency activities."[50] Riverkeeper questions the degree to which NRC will undertake *any* of NMFS' suggestions, given NRC's historical disinclination to "require" licensees to undertake any activities beyond what is specifically dictated by statutes and regulations. NRC has a noted history of ignoring important environmental considerations related to the operation of Indian Point, while taking the stance that the plant is in compliance with applicable laws and regulations. A level of assurance or plan to ensure that NRC meaningfully considers NMFS' Conservation Recommendations, is, therefore, advisable.

In any event, NMFS' Conservation Recommendations fail to achieve a net conservation benefit to the endangered sturgeon populations in the Hudson River.[51] That is, they demonstrably fail to mitigate the significant impact that Indian Point will have on endangered sturgeon during the proposed relicensing period. There is simply no mitigation plan articulated to ensure that endangered sturgeon are adequately protected during the proposed 20 additional years of operation Entergy is seeking for Indian Point.

based on the existing draft BiOp, the efficacy of a closed-cycle cooling system should still be analyzed before finalizing the BiOp.

[48] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 120-21.

[49] *Id.* at 125.

[50] *Id.*

[51] *Id.*

Thank you for your consideration of the foregoing comments. Please do not hesitate to contact me at 914-478-4501, or via e-mail at dbrancato@riverkeeper.org, to discuss anything further.

Sincerely,

Deborah Brancato

Deborah Brancato
Staff Attorney

cc: Sherwin Turk
Office of General Counsel
Mail Stop: 0-15D21
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
Sherwin.Turk@nrc.gov

ATTACHMENT 1

Memo: Pisces Conservation Ltd

To: **Deborah Brancato (Riverkeeper)**

From: **Peter Henderson**

Date: **Wednesday, 21 November 2012**

Re: **Sturgeon and Indian Point**

Summary Comments on NMFS' Draft BiOp

The first point to note is that it is recognised that impingement will kill appreciable numbers of sturgeon: "the continued operation of IP2 and IP3 . . . through the proposed extended license period . . . will result in the impingement and mortality of 562 shortnose sturgeon and 219 juvenile New York Bight DPS Atlantic sturgeon" (Draft BiOp at p.108). For endangered long-lived species, these numbers cannot be considered trivial. Imagine the concern if wind turbines were predicted to kill the same numbers of protected bird species.

A second key point is that all the calculations and predictions are based on data collected prior to 1991. Not only have the populations of both species likely changed since this period, but plant operation and technical specification has also changed. For example, no sampling has been undertaken since the Ristroph screens were installed. There is, therefore, no relevant data on sturgeon survival.

The species are considered in turn below.

Shortnose Sturgeon

The first point to note is the importance of the Hudson to this species. "The Hudson River population of shortnose sturgeon is the largest in the United States." (Draft BiOp at p.108). Given the poor health of many other populations, the Hudson is of special significance and merits particular protection.

Recruitment of this species varies appreciably through time and seems to be linked to conditions in the fall. Recruitment was particularly favourable 1986-1992 and this explains the increased population observed in the late 1990s. However, care must be taken not to assume such favourable recruitment will persist, particularly given potential climate change impacts.

To summarise the Draft BiOp, it concludes that the proposed action will not affect the shortnose sturgeon population because the number killed is a small proportion of the total population. It is claimed that the population is stable and possibly at carrying capacity, however, there is no evidence presented to scientifically support this finding.

The size and age structure of sturgeon populations must be considered in conjunction with numerical abundance. Historically populations of long-lived fish such as sturgeon held some old and very large individuals. Human interference has reduced the average age of the populations. Indian Point will contribute to this reduction as impingement losses effectively reduce the likelihood that an individual will reach old age.

While in-combination effect arguments are recognised, the lack of information on the range of mortality rates attributable to man and their combined impact on the Hudson population is unclear.

Atlantic Sturgeon

Recent spawning is only known from the Hudson and Delaware rivers; therefore, the fate of Atlantic sturgeon in the Hudson is of considerable importance.

The present information available on Atlantic sturgeon impingement and juvenile abundance is poor as it comes from pre-1991 studies. It is estimated that impingement will kill a small proportion of the juvenile population and, therefore, will not likely jeopardise the continued existence of the Atlantic Sturgeon. However, we seek a recovery of this species to levels where the population is sustainable and able to take the inevitable setbacks. Impingement mortality and habitat degradation do not contribute to, but hinder, recovery.

There is some indication that the population is presently increasing, but this is poor and gives no grounds to claim that power plant losses are of no import.

As with the shortnose sturgeon, in-combination effects are not well quantified.

Pisces Conservation Ltd
IRC House, The Square
Pennington, Lymington
Hampshire, SO41 8GN, UK
pisces@pisces-conservation.com
www.irchouse.demon.co.uk
www.pisces-conservation.com
Phone: 44 (0) 1590 674000
Fax 44 (0) 1590 675599

Riverkeeper Amended Contention RK-EC-8A:

Attachment 6

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

JAN 30 2013

Dr. Amy Hull, Branch Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Program
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

RE: Biological Opinion for Continued Operations of Indian Point Nuclear Generating Unit Nos. 2 and 3

Dear Dr. Hull:

Please find enclosed a copy of NOAA's National Marine Fisheries Service's (NMFS) Biological Opinion (Opinion) on the effects of the continued operation of the Indian Point Nuclear Generating Station Units 2 and 3 (Indian Point, IP2 and IP3) pursuant to existing operating licenses and proposed renewed operating licenses to be issued to Entergy Nuclear Operations, Inc. (Entergy) by the U.S. Nuclear Regulatory Commission (NRC). In this Opinion, we conclude that the continued operation of IP2 and IP3 are likely to adversely affect but is not likely to jeopardize the continued existence of endangered shortnose sturgeon or the Gulf of Maine, New York Bight or Chesapeake Bay Distinct Population Segment (DPS) of Atlantic sturgeon.

As we have discussed previously, we have concerns regarding the significant uncertainty regarding the proposed action. Hearings related to the State Pollution Discharge Elimination System (SPDES) permit for IP2 and IP3 as well as New York's denial of a Clean Water Act Section 401 Water Quality Certificate began in the Fall of 2011 and have not been completed. Additionally, hearings regarding the proposed issuance of renewed operating licenses began in October 2012. We previously asked you to consider withdrawing your request for consultation until issues related to the uncertainties of future operations of the operation of IP2 and IP3 could be resolved. However, you have determined that conducting consultation now is appropriate and as you requested, we have completed consultation, considering effects of the continued operation of IP2 and IP3 under the terms of the existing licenses up until such time the NRC makes licensing decisions as well as under the terms of the proposed renewed operating licenses, as defined by NRC staff in the Final Supplemental Environmental Impact Statement and Biological Assessments. It is our understanding that you retain discretionary control over the operation of the facilities for the benefit of listed species, or such involvement or control is authorized by law, so that reinitiation of consultation with NMFS is required should any of the criteria for reinitiation be met (see below), including a change in the operations of IP2 and/or IP3 resulting from the hearings regarding the SPDES permit and 401 certificate or the hearings with the Atomic Safety and Licensing Board regarding relicensing.

Our Opinion includes an Incidental Take Statement (ITS) that applies to both IP2 and IP3. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements, including any state endangered species laws or regulations, except for the prohibition against taking in ESA Section 9. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to the agency action is not considered to be prohibited under the ESA, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

This ITS exempts the following take:

- A total of 2 dead or alive shortnose sturgeon (injure, kill, capture or collect) and 2 dead or alive New York Bight DPS Atlantic sturgeon (injure, kill, capture or collect) impinged at the Unit 1[1] intakes (Ristroph screens) from now until the IP2 proposed renewed operating license would expire on September 28, 2033.
- A total of 395 dead or alive shortnose sturgeon (injure, kill, capture or collect) and 269 New York Bight DPS Atlantic sturgeon (injure, kill, capture or collect) impinged at Unit 2 intakes (Ristroph screens) from now until the IP2 proposed renewed operating license would expire on September 28, 2033.
- A total of 167 dead or alive shortnose sturgeon (injure, kill, capture or collect) and 145 dead or alive New York Bight DPS Atlantic sturgeon (injure, kill, capture or collect) impinged at the Unit 3 intakes (Ristroph screens) from now until the IP3 proposed renewed operating license would expire on December 12, 2035.
- All shortnose sturgeon with body widths greater than 3" impinged at the IP1, IP2 and IP3 trash racks (capture or collect).
- All Atlantic sturgeon with body widths greater than 3" impinged at the IP1, IP2 and IP3 trash racks (capture or collect). These Atlantic sturgeon will originate from the New York Bight (92%), Gulf of Maine (6%) and Chesapeake Bay DPSs (2%).

This ITS applies to the currently authorized operating periods and the proposed extended operating periods. The ITS specifies reasonable and prudent measures necessary to minimize and monitor take of shortnose and Atlantic sturgeon. NRC has a continuing duty to regulate the activity covered by this ITS. If NRC (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant, Entergy, to adhere to the terms and conditions of the ITS through enforceable terms, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NRC or the applicant must report the progress of the action and its impact on the species to us as specified in the ITS [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

---

[1] As explained in the Opinion, water withdrawn through the Unit 1 intakes is used for service water for the operation of IP2.

This Opinion concludes formal consultation for the proposed actions as currently defined. Reinitiation of this consultation is required if: (1) the amount or extent of taking specified in the ITS is exceeded; (2) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) project activities are subsequently modified in a manner that causes an effect to the listed species that was not considered in this Biological Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. As explained above, we expect NRC to request reinitiation of consultation should any changes be proposed for the operation of IP2 and/or IP3 that would cause effects to shortnose or Atlantic sturgeon not considered in this Opinion. For example, we expect that if a decision is made to install cooling towers, cylindrical wedge-wire screens, or any other technology associated with the intakes, consultation will be reinitiated, given that effects to shortnose and Atlantic sturgeon from the construction or installation of these technologies as well as the effects of operation with these technologies in place, could be very different than the effects considered in this Opinion.

This Opinion only analyzes the operations of IP2 and IP3 under the same conditions that appear in the existing licenses and SPDES permit, and the analysis and conclusions cannot be interpreted to apply to a different time period or different set of operating conditions. It would not be appropriate to use the Opinion as an indication of a "worst-case scenario," given the Opinion's analysis and determinations may need to be modified as the definition of the proposed actions and effects, the environmental baseline, and the status of species protected under the ESA all may change. Additionally, this Opinion is not a substitute for any outstanding coordination that may remain with the State of New York regarding any State endangered species laws or regulations.

Should you have any questions regarding this Biological Opinion please contact Julie Crocker of my staff ((978)282-8480 or Julie.Crocker@noaa.gov). I appreciate your assistance with the protection of threatened and endangered species and look forward to continued cooperation with NRC during future Section 7 consultations.

Sincerely,

For John K. Bullard
Regional Administrator

Enclosure

CC: Balsam, Logan, Turk – NRC
EC: Crocker– F/NER3
Williams, GCNE

File Code: Sec 7 NRC – Indian Point 2012
PCTS: NER-2012-02252

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Agency: Nuclear Regulatory Commission

Activity: **Continued Operations of the Indian Point Nuclear Generating Station, Units 2 and 3, pursuant to existing and proposed renewed operating licenses**
NER-2012-2252

Conducted by: NOAA's National Marine Fisheries Service
Northeast Regional Office

Date Issued: 30 JAN 2013

Approved by: for JOHN BULLARD

Table of Contents

1.0 INTRODUCTION

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) issued in accordance with section 7 of the Endangered Species Act of 1973, as amended, on the effects of the continued operation of the Indian Point Nuclear Generating Station (Indian Point) pursuant to an existing operating license issued by the Nuclear Regulatory Commission (NRC) in accordance with the Atomic Energy Act of 1954 as amended (68 Stat. 919) and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242) as well as proposed extended operating licenses.

This Opinion is based on information provided in a Biological Assessment (BA) dated December 2010, the *Final Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38 Regarding Indian Point Nuclear Generating Unit 2 and 3* dated December 2010, a draft Supplement to that EIS dated June 2012, information submitted to us by the NRC via letter dated May 16, 2012, permits issued by the State of New York, information submitted to NMFS by Entergy and other sources of information. We will keep a complete administrative record of this consultation at the NMFS Northeast Regional Office, Gloucester, Massachusetts.

2.0 BACKGROUND AND CONSULTATION HISTORY

Indian Point Nuclear Generating Units 2 and 3 (IP2 and IP3) are located on approximately 239 acres (97 hectares (ha)) of land in the Village of Buchanan in upper Westchester County, New York (project location is illustrated in Appendix I, Figures 1 and 2). The facility is on the eastern bank of the Hudson River at river mile (RM) 43 (river kilometer (RKM) 69) about 2.5 miles (mi) (4.0 kilometers (km)) southwest of Peekskill, the closest city, and about 43 mi (69 km) north of the southern tip of Manhattan. Both IP2 and IP3 use Westinghouse pressurized-water reactors and nuclear steam supply systems (NSSSs). Primary and secondary plant cooling is provided by a once-through cooling water intake system that supplies cooling water from the Hudson River. Indian Point Nuclear Generating Station Unit 1 (IP1, now permanently shut down[1]) shares the site with IP2 and IP3. IP1 is located between IP2 and IP3. In 1963, IP1 began operations. IP1 was shut down on October 31, 1974, and is in a safe storage condition (SAFSTOR) awaiting final decommissioning. Construction began on IP2 in 1966 and on IP3 in 1969.

The Atomic Energy Commission (AEC), the predecessor to the NRC, initially licensed IP2 on September 28, 1973. The AEC issued a 40-year license for IP2 that was set to expire on September 28, 2013. IP2 was originally licensed to the Consolidated Edison Company, which sold that facility to Entergy in September 2001. IP3 was initially licensed on December 12, 1975, for a 40-year period that was set to expire on December 12, 2015. While the Consolidated Edison Company of New York originally owned and operated IP3, it was later conveyed to the Power Authority of the State of New York (PASNY – the predecessor to the New York Power Authority [NYPA]). PASNY/NYPA operated IP3 until November 2000 when it was sold to Entergy. NRC indicated that Entergy submitted timely license renewal applications; therefore, the licenses for IP2 and IP3 will remain in effect until the renewed licenses are issued or other action taken.

---

[1] The intake for IP1 is used for service water for IP2; however, IP1 no longer is used for generating electricity and no cooling water is withdrawn from the IP1 intake. This use is discussed fully below.

2.1 Endangered Species Act Consultation

The Endangered Species Act was enacted in 1973. However, there was no requirement in the 1973 Act for the Secretary to produce a written statement setting forth his biological opinion on the effects of the action and whether the action will jeopardize the continued existence of listed species and/or destroy or adversely modify critical habitat. It was not until Congress amended the Act in 1978 that the Secretary was required to produce a Biological Opinion. The 1973 Act, including as amended in 1978, prohibited the "take" of endangered species. NMFS could issue a Section 10 incidental take permit to those who applied for incidental take authorization. In 1982, Congress amended the Act to provide for an "Incidental Take Statement" (ITS) in a Biological Opinion that specifies the level of incidental "take," identifies measures to minimize the level of incidental "take," and exempts any incidental "take" that occurs in compliance with those measures. Until we issued a Biological Opinion with ITS for shortnose sturgeon in 2011, we had not exempted any incidental take at IP1, IP2 and IP3 from the Section 9 prohibitions against take, either through a Section 10 permit or an ITS. The ITS issued with the 2011 Opinion was only prospective, that is, it covered the period from September 28, 2013-September 28, 2033 (IP1 & 2) and December 12, 2015-December 12, 2035 (IP3)..

As explained below, beginning in 1977, EPA held a series of hearings (Adjudicatory Hearing Docket No. C/II-WP-77-01) regarding the once through cooling systems at Indian Point, Roseton, Danskammer and Bowline Point, all of which are power facilities located along the Hudson River. During the course of these hearings, Dr. Mike Dadswell testified on the effects of the Indian Point facility on shortnose sturgeon. In a filing dated May 14, 1979, NOAA submitted this testimony to the U.S. EPA as constituting NMFS "Biological Opinion on the impacts of the utilities' once through cooling system on the shortnose sturgeon." The filing notes that this opinion is required by section 7 of the ESA of 1973, as amended.

In this testimony, Dr. Dadswell provides information on the life history of shortnose sturgeon and summarizes what was known at the time about the population in the Hudson River. Dr. Dadswell indicates that at the time it was estimated that there were approximately 6,000 adult and sub-adult shortnose sturgeon in the Hudson River population (Dadswell 1979) and that the population had been stable at this number between the 1930s and 1970s. Dr. Dadswell determined that there is no known entrainment of shortnose sturgeon at these facilities and little, if any, could be anticipated. Based on available information regarding impingement at IP2 and IP3, Dadswell estimated a worst case scenario of 35 shortnose sturgeon impingements per year, including 21 mortalities (assuming 60% impingement mortality). Dadswell estimated that this resulted in a loss of 0.3-0.4% of the shortnose sturgeon population in the Hudson each year and that this additional source of mortality will not "appreciably reduce the likelihood of the survival and recovery of the shortnose sturgeon." In conclusion Dadswell stated that the once through cooling systems being considered in the case were "not likely to jeopardize the continued existence of the shortnose sturgeon because, even assuming 100% mortality of impinged fish, its contribution to the natural annual mortality is negligible." Dr. Dadswell did note that as there is no positive benefit to impingement, any reductions in the level of impingement would aid in the conservation of the species. Incidental take of shortnose sturgeon at IP2 and IP3 was not exempted from the prohibitions on take by this testimony or "biological opinion." No additional ESA consultation occurred between NRC and NMFS on the operation of IP2 and IP3 until NRC began discussions with us in August 2007regarding effects to shortnose sturgeon of operations during the proposed extended operating period. This consultation was completed with the issuance of a Biological Opinion by us in October 2011.

In advance of relicensing proceedings, NRC began coordination with us in 2007. In a letter dated August 16, 2007, NRC requested information from us on federally listed endangered or threatened species, as well as on proposed or candidate species, and on any designated critical habitats that may occur in the vicinity of IP2 and IP3. In our response, dated October 4, 2007, we expressed concern that the continued operation of IP2 and IP3 could have an impact on the shortnose sturgeon *(Acipenser brevirostrum)*. In a letter dated December 22, 2008, NRC requested formal consultation with us to consider effects of the proposed relicensing on shortnose sturgeon. With this letter, NRC transmitted a BA. In a letter dated February 24, 2009, we requested additional information on effects of the proposed relicensing on shortnose sturgeon. In a letter dated December 10, 2010, NRC provided the information that was available and transmitted a revised BA. In the original BA, NRC staff relied on data originally supplied by the applicant, Entergy Nuclear Operations, Inc. (Entergy). NRC sought and Entergy later submitted revised impingement data, which was incorporated into the final BA. Mathematical errors in the original data submitted to the NRC resulted in overestimates of the impingement of shortnose sturgeon that the NRC staff presented in the 2008 BA. The December 10 submittal contained all of the information necessary for us to write our Opinion; therefore, consultation on the effects of the proposed relicensing on shortnose sturgeon was initiated on December 10, 2010.

On June 16, 2011, we received information regarding Entergy's triaxial thermal plume study and NMFS staff obtained a copy of the study and supporting documentation from NYDEC's webpage on that date. Additional information regarding the intakes was provided by Entergy via conference call on June 20, June 22, and June 29, 2011. Supplemental information responding to specific questions raised by us regarding the thermal plume was submitted by Entergy via e-mail on July 8, July 25, and August 5, 2011. NRC provided us with a supplement to the December 2010 BA considering the new thermal plume information, on July 27, 2011. We transmitted a draft Opinion to NRC on August 26, 2011. The draft Opinion was subsequently transmitted by NRC to Entergy. Comments on the draft Opinion were received by us from NRC on September 6, 2011 and September 20, 2011. Comments were received by us from Entergy on September 6, 2011. Additionally, we received letters regarding the draft Opinion from New York State (dated September 6, 2011) and Hudson Riverkeeper (dated September 15, 2011). Additional clarifying information on the proposed action was received from NRC and Entergy throughout September 2011. We issued a Biological Opinion on October 14, 2011. In this Opinion we concluded that operation of IP2 and IP3 during the extended operating period was likely to adversely affect but not likely to jeopardize the continued existence of shortnose sturgeon.

As explained in the "Effects of the Action" section of the 2011 Opinion, we determined an average of 5 shortnose sturgeon per year are likely to be impinged at Unit 2 during the extended operating period, with a total of no more than 104 shortnose sturgeon over the 20 year period (dead or alive). Additionally, over the 20 year operating period, we estimated that an additional 6 shortnose sturgeon (dead or alive) were likely to be impinged at the Unit 1 intakes which will provide service water for the operation of Unit 2. We estimated that at Unit 3, an average of 3 shortnose sturgeon are likely to be impinged per year during the extended operating period, with a total of no more than 58 shortnose sturgeon (dead or alive) taken as a result of the operation of

Unit 3 over the 20 year period. This level of take was exempted through an Incidental Take Statement that applies only to the period when the facility operates under a new operating license (September 28, 2013 through September 28, 2033 for Units 1 and 2; December 12, 2015 through December 12, 2035 for Unit 3). The 2011 Opinion was to become effective once new operating licenses were issued by NRC. The Nuclear Regulatory Commission (NRC) has not yet made a decision on whether to issue the extended operating licenses.

As described in 50 CFR§ 402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) the amount or extent of taking specified in the ITS is exceeded; (b) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) any of the identified actions are subsequently modified in a manner that causes an effect to the listed species that was not considered in the Opinion; or (d) a new species is listed or critical habitat designated that may be affected by the identified actions. Based on prior communications with NRC, it is our understanding that for Indian Point facilities, NRC retains discretionary involvement or control to benefit listed species, or such involvement or control is authorized by law, and that NRC will reinitiate consultation if any of the criteria above are satisfied.

On February 6, 2012, we listed five distinct population segments (DPS) of Atlantic sturgeon as threatened (Gulf of Maine DPS) or endangered (New York Bight, Chesapeake Bay, Carolina and South Atlantic DPSs) (see 77 FR 5880 and 77 FR 5914). Atlantic sturgeon occur in the Hudson River and are known to be affected by operations of IP2 and IP3.

In a letter dated May 16, 2012, NRC requested reinitiation of the 2011 consultation to consider effects of continued operations of IP2 and IP3 on Atlantic sturgeon. The scope of NRC's request for consultation was clarified in a July 3, 2012, telephone call between NMFS and NRC staff. NRC requests that the consultation consider effects to shortnose sturgeon and five DPSs of Atlantic sturgeon of operations of IP2 and IP3 pursuant to the existing operating licenses and the operation of IP2 and IP3 during the proposed extended operating period. Therefore, the federal actions under consideration are authorization of operations of IP2 and IP3 by the NRC pursuant to licenses issued in 1973 and 1975, respectively, and operations pursuant to proposed new licenses, which NRC may issue at any time and would extend operations for 20 years beyond the expiration of the original licenses. Consultation was initiated on May 17, 2012 (the date the May 16 letter was received). On July 23, 2012, Entergy submitted additional information to us and NRC regarding impingement of shortnose and Atlantic sturgeon (Entergy 2012). Subsequently, by mutual agreement of NRC and NMFS, we extended the consultation period by 60 days to allow time for review and incorporation of this new information, as appropriate. We transmitted a draft Opinion to NRC on October 26, 2012. The Opinion was subsequently transmitted by NRC to Entergy. We received comments from NRC and Entergy on November 9. On a November 26, 2012, conference call, NRC requested the consultation period be extended by seven days to allow them to suggest revised language in the Incidental Take Statement. On December 5, 2012, NRC requested the consultation period be extended to January 9, 2013. Entergy agreed to that extension. NRC and Entergy raised additional comments related to the ITS on a January 8, 2013 conference call. Entergy submitted suggested changes to the Terms and Conditions on January 9, 2013. To allow NMFS time to consider the additional comments, NRC and Entergy requested an extension until January 30, 2013, the new due date. This Opinion supercedes the Opinion issued by us on October 14, 2011.

3.0 DESCRIPTION OF THE PROPOSED ACTIONS

As noted above, the proposed Federal action is the continued operation of Indian Point Units 2 and 3 pursuant to two separate licenses issued by NRC in 1973 and 1975, respectively, as well as continued operation of IP2 and IP3 pursuant to NRC's two proposed renewed operating licenses. The current 40-year licenses expire in 2013 (IP2) and 2015 (IP3). According to NRC, NRC's "timely renewal" provision (in 10 CFR 2.109(b)) provides that if a license renewal application is timely filed, which NRC asserts the Entergy application was, the current license is not deemed to have expired until the application has been finally determined (i.e., until a licensing decision is made). Thus, pursuant to this provision, the current operating licenses will not expire until the license renewal proceeding has concluded. NRC's proposed relicensing would authorize the extended operation of IP2 and IP3 for an additional 20 years (i.e., through September 28, 2033 and December 12, 2035, respectively). In this Opinion, we consider the potential impacts of the continued operation of the facilities from now through the proposed extended operation periods on shortnose and Atlantic sturgeon.

Details on the operation of the facilities under the terms of the existing licenses and over the extended operating periods, as proposed by Entergy in the license application and as described by NRC in the FEIS, DSEIS and BA, and are summarized below. Both units withdraw water from and discharge water to, the Hudson River. As described by NRC in the Final SEIS (NRC 2010), in 1972, Congress assigned authority to administer the Clean Water Act (CWA) to the US Environmental Protection Agency (EPA). The CWA further allowed EPA to delegate portions of its CWA authority to states. On October 28, 1975, EPA authorized the State of New York to issue National Pollutant Discharge Elimination System (NPDES) permits. New York's NPDES, or State Pollutant Discharge Elimination System (SPDES), program is administered by the NY Department of Environmental Conservation (NYDEC). NYDEC issues and enforces SPDES permits for IP2 and IP3.

Section 316(b) of the Clean Water Act of 1977 requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). EPA regulates impingement and entrainment under Section 316(b) of the CWA through the NPDES permit process. Administration of Section 316(b) has also been delegated to NYDEC, and that provision is implemented through the SPDES program.

Neither IP2 nor IP3 can operate without cooling water, and NRC is responsible for authorizing the operation of nuclear facilities, as well as approving any extension of an initial operating license through the license renewal process. Intake and discharge of water through the cooling water system would not occur but for the operation of the facility pursuant to a renewed license; therefore, the effects of the cooling water system on shortnose and Atlantic sturgeon are a direct effect of the proposed action. The effects of the proposed Federal action-- the continued operation of IP2 and IP3 under the two existing licenses and the two proposed renewed licenses, which necessarily involves the removal and discharge of water from the Hudson River-- are shaped not only by the terms of the renewed operating license but also by the NYDEC 401

Water Quality Certification and any conditions it may contain that would be incorporated into its SPDES permits. This Opinion will consider the effects of the ongoing operation of IP2 and IP3, and their operation pursuant to the extended Operating License to be issued by the NRC, and the SPDES permits issued by NYDEC that are already in effect. NRC requested consultation on the operation of the facilities under the existing NRC license terms and the existing SPDES permits, even though a new SPDES permit might be issued in the future. A complete history of NYDEC permits is included in NRC's FSEIS at Section 2.2.5.3 (Regulatory Framework and Monitoring Programs) and is summarized below.

3.1 NPDES/SPDES Permits

Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). In July 2004, the EPA published the Phase II Rule implementing Section 316(b) of the CWA for Existing Facilities (69 FR 41576), which applied to large power producers that withdraw large amounts of surface water for cooling (50 MGD or more) (189,000 m3/day or more). The rule became effective on September 7, 2004 and included numeric performance standards for reductions in impingement mortality and entrainment that would demonstrate that the cooling water intake system constitutes BTA for minimizing impingement and entrainment impacts. Existing facilities subject to the rule were required to demonstrate compliance with the rule's performance standards during the renewal process for their NPDES permit through development of a Comprehensive Demonstration Study (CDS). As a result of a Federal court decision, EPA officially suspended the Phase II rule on July 9, 2007 (72 FR 37107) pending further rulemaking. EPA instructed permitting authorities to utilize best professional judgment in establishing permit requirements on a case by-case basis for cooling water intake structures at Phase II facilities until it has resolved the issues raised by the court's ruling.

The licenses issued by the AEC for IP2 and IP3 initially allowed for the operation of those facilities with once-through cooling systems. However, the licenses required the future installation of closed-cycle cooling systems at both facilities, by certain dates, because of the potential for long term environmental impact from the once-through cooling systems on aquatic life in the Hudson River, particularly striped bass. A closed cycle cooling system is expected to withdraw approximately 90-95% less water than a once through cooling system. The license for IP2 was amended by the NRC in 1975, and the license for IP3 was amended by the NRC in 1976, to include requirements for the installation and operation of wet closed-cycle cooling systems at the facilities.

NRC eventually concluded that the operating licenses for the facilities should be amended to authorize construction of natural draft cooling towers at each Unit. Prior to the respective deadlines for installation of closed-cycle cooling at the Indian Point facilities, however, the NRC's authority to require the retrofit due to water quality impacts under federal nuclear licenses was superseded by comprehensive amendments to the federal Water Pollution Prevention and Control Act (the CWA) and creation of the NPDES program.

In 1975, the EPA issued separate NPDES permits for Units 2 and 3, pursuant to provisions of the CWA, chiefly § 316 (33 U.S.C. § 1326), that required both facilities to discontinue discharging heated effluent from the main condensers. The NPDES permits provided that "heat may be discharged in blowdown from a re-circulated cooling water system." The intent of these conditions was to require the facilities to install closed-cycle cooling systems in order to reduce the thermal and other adverse environmental impacts from the operation of Indian Point's CWISs upon aquatic organisms in the Hudson River. In 1977, the facilities' owners, Consolidated Edison Company of New York and PASNY/NYPA, requested administrative hearings with the EPA to overturn these conditions.

In October 1975, NYDEC received approval from the EPA to administer and conduct a State permit program pursuant to the provisions of the federal NPDES program under CWA § 402. Since then, NYDEC has administered that program under the SPDES permit program. As a result, NYDEC has the authority, under the CWA and state law, to issue SPDES permits for the withdrawal of cooling water for operations at the Indian Point facilities and for the resulting discharge of waste heat and other pollutants into the Hudson River.

As previously noted, in 1977 the then-owners of the Indian Point nuclear facilities sought an adjudicatory proceeding to overturn the EPA-issued NPDES permit determinations that limited the scope of the facilities' cooling water intake operations. The EPA's adjudicatory process lasted for several years before culminating in a multi-party settlement known as the Hudson River Settlement Agreement[2] (HRSA). The HRSA was initially a ten-year agreement whereby the owners of certain once-through cooled electric generating plants on the Hudson River, including IP2 and IP3, would collect biological data and complete analytical assessments to determine the scope of adverse environmental impact caused by those facilities. According to the NYDEC, the intent of the HRSA was that, based upon the data and analyses provided by the facilities, the Department could determine, and parties could agree upon, the best technology available to minimize adverse environmental impact on aquatic organisms in the Hudson River from these facilities in accordance with 6 NYCRR § 704.5. The Settlement obligated the utilities to undertake a series of operational steps to reduce fish kills, including partial outages during the key spawning months. In addition, the utilities agreed to fund and operate a striped bass hatchery, conduct biological monitoring, and set up a $12 million endowment for a new foundation for independent research on mitigating fish impacts by power plants. The agreement became effective upon Public Service Commission approval on May 8, 1981. The terms of the 1980 HRSA were extended through a series of four separate stipulations of settlement and judicial consent orders that were entered in Albany County Supreme Court [Index No. 0191-ST3251]. The last of these stipulations of settlement and judicial consent orders, executed by the parties in 1997, expired on February 1, 1998.

In 1982, NYDEC issued a SPDES permit for IP2 and IP3, and other Hudson River electric generating facilities, as well as a CWA § 401 WQC for the facilities. The 1982 SPDES permit for IP2 and IP3 contained special conditions for reducing some of the environmental impact from

[2] The signatory parties to the HRSA were USEPA, the Department, the New York State Attorney General, the Hudson River Fishermen's Association, Scenic Hudson, the Natural Resources Defense Council, Central Hudson Gas & Electric Co., Consolidated Edison Co., Orange & Rockland Utilities, Niagara Mohawk Power Corp., and PASNY. Entergy was not a party to the HRSA because it did not own the Indian Point facilities at any time during the period covered by the HRSA. NOAA was not a party to the HRSA.

the facilities' cooling water intakes but, based upon provisions of the HRSA, the permit did not require the installation of any technology for minimizing the number of organisms entrained by the facilities each year. Similarly, based upon provisions of the HRSA, the 1982 § 401 WQC did not make an independent determination that the facilities complied with certain applicable State water quality standards at that time, including 6 NYCRR Part 704 – Criteria Governing Thermal Discharges.

In accordance with the provisions of the HRSA, NYDEC renewed the SPDES permit for IP2 and IP3 in 1987 for another 5-year period. As with the 1982 SPDES permit, the 1987 SPDES permit for IP2 and IP3 contained certain measures from the HRSA that were intended to mitigate, but not minimize, the adverse environmental impact caused by the operation of the facilities' cooling water intakes. The 1987 SPDES permit expired on October 1, 1992. Prior to the expiration date, however, the owners of the facilities at that time, Consolidated Edison and NYPA, both submitted timely SPDES permit renewal applications to the Department and, by operation of the State Administrative Procedure Act (SAPA), the 1987 SPDES permit for Units 2 and 3 is still in effect today. Entergy purchased Units 2 and 3 in 2001 and 2000, respectively, and the 1987 SAPA-extended SPDES permit for the facilities was subsequently transferred to Entergy.

In November 2003, NYDEC issued a draft SPDES permit for IP2 and IP3 that required Entergy, among other things, to retrofit the Indian Point facilities with closed-cycle cooling or an equivalent technology in order to minimize the adverse environmental impact caused by the CWISs in accordance with 6 NYCRR § 704.5 and CWA § 316(b). The draft permit contains conditions which address three aspects of operations at Indian Point: conventional industrial-wastewater pollutant discharges, thermal discharge, and cooling water intake. Limits on the conventional industrial discharges are not proposed to be changed significantly from the previous permit. The draft permit does, however, contain new conditions addressing the thermal discharge and additional new conditions to implement the measures NYDEC has determined to be the best technology available for minimizing impacts to aquatic resources from the cooling water intake, including the installation of a closed cycle cooling system at IP2 and IP3. With respect to thermal discharges, the draft SPDES permit would require Entergy to conduct a tri-axial (three-dimensional) thermal study to document whether the thermal discharges from IP2 and IP3 comply with state water quality criteria. The draft permit states that if IP2 and IP3 do not meet state standards, Entergy may apply for a modification of those criteria in an effort to demonstrate to NYDEC that such criteria are unnecessarily restrictive and that the requested modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish and wildlife in the Hudson River, which is an applicable CWA water quality-related standard. The draft permit also states that Entergy may propose, within a year of the permit's becoming effective, an alternative technology or technologies that can minimize adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3. In order to implement closed-cycle cooling, the draft permit would require Entergy to submit a pre-design engineering report within one year of the permit's effective date. Within one year after the submission of the report, Entergy must submit complete design plans that address all construction issues for conversion to closed-cycle cooling. In addition, the draft permit requires Entergy to obtain approvals for the system's construction from other government agencies, including modification of the operating licenses for IP2 and IP3 from the NRC. While steps are being taken to implement BTA, Entergy would be required to schedule and take annual generation outages of no fewer than 42 unit-days during the peak entrainment season among other measures. In 2004, Entergy requested an adjudicatory hearing with NYDEC on the draft SPDES permit. That SPDES permit adjudicatory process is presently ongoing, and its outcome is uncertain at this time.

There is significant uncertainty associated with the conditions of any new SPDES permit. In the 2003 draft, NYDEC determined that cooling towers were the BTA to minimize adverse environmental effects. In a 2010 filing with NYDEC, Entergy proposed to use a system of cylindrical wedgewire screens, which Entergy states would reduce impingement and entrainment mortality to an extent comparable to the reductions in impingement and entrainment loss expected to result from operation with cooling towers. As no determination has been made regarding a revised draft SPDES permit or a final permit, it is unknown what new technology, if any, will be required to modify the operation of the facility's cooling water intakes. The 1987 SPDES permit is still in effect and will remain in effect until a new permit is issued and becomes effective. No schedule is available for the issuance of a revised draft or new final SPDES permit and the content of any SPDES permit will be decided as a result of the adjudication process. Therefore, in this consultation, we have considered effects of the continued operation of the Indian Point facility through the end of extended operating period with the 1987 SPDES permit in effect. This scenario is the one defined by NRC as its proposed action in the BA provided to NMFS in which NRC considered effects of the operation of the facility during the extended operating period on shortnose and Atlantic sturgeon. Therefore, it is the subject of this consultation. However, if a new SPDES permit is issued, NRC and NMFS would have to determine if reinitiation of this consultation is necessary to consider any effects of the operation of the facility on sturgeon that were not considered in this Opinion, including operation of the facility with cylindrical wedge wire screens. It is possible the effects of the construction, layout, and use of an intake system using cylindrical wedge wire screens will affect shortnose and/or Atlantic sturgeon in a manner and to a degree that is very different from the effects considered in this Opinion, and as a result, necessitate reinitiation of this consultation.

3.2 401 Water Quality Certificate (WQC)

On December 7, 1970, NYSDEC issued a certification for IP1 and IP2, pursuant to §21(b) of the Water Quality Improvement Act 1 -the precursor to §401. On April 24, 1973, NYSDEC issued a WQC for the operational testing period for IPI and IP2. On September 24, 1973, NYSDEC issued a WQC for full operation of IP1 and IP2. On May 2, 1975, NYSDEC issued a WQC for operation of Indian Point 3 ("IP3"). On April 24, 1981, NYSDEC issued a subsequent WQC for operation of IP1, IP2 and IP3. IP2 and IP3 currently operate pursuant to the 1981 WQC.

On April 6, 2009, NYDEC received a Joint Application for a federal CWA § 401 WQC on behalf of Entergy Indian Point Unit 2, LLC, Entergy Indian Point Unit 3, LLC, and Entergy Nuclear Northeast (collectively Entergy). The Joint Application for § 401 WQC was submitted to NYDEC as part of Entergy's NRC license renewal. Pursuant to the CWA, a state must issue a certification verifying that an activity which results in a discharge into navigable waters, such as operation of the Indian Point facilities, meets state water quality standards before a federal license or permit for such activity can be issued. Entergy has requested NYDEC to issue a § 401 WQC to run concurrently with any renewed nuclear licenses for the Indian Point facilities.

In a decision dated April 2, 2010, NYDEC determined that the facilities, whether operated as they are currently or operated with the addition of a cylindrical wedge-wire screen system (NYDEC notes that this proposal was made by Entergy in a February 12, 2010, submission), "do not and will not comply with existing New York State water quality standards." Accordingly, pursuant to 6 NYCRR Part 621 (Uniform Procedures), NYDEC denied Entergy's request for a §401 WQC (NYDEC 2010). The reasons for denial, as stated by NYDEC were related to impingement and entrainment of aquatic organisms, the discharge of heated effluent, and failure to implement what NYDEC had determined to be the Best Technology Available (closed cycle cooling towers), to minimize adverse environmental impacts. Entergy has appealed the denial. The matter is currently under adjudication in the state administrative system, and the results are uncertain. If New York State ultimately issues a WQC, it may contain conditions that alter the operation of the facility and its cooling water system. If this occurs, NMFS and NRC would need to review the modifications to operations to determine if consultation would need to be reinitiated.

3.3 Description of Water Withdrawals

IP2 and IP3 have once-through condenser cooling systems that withdraw water from, and discharge water to, the Hudson River. The maximum design flow rate for each cooling system is approximately 1,870 cubic feet per second (cfs), 840,000 gallons per minute (gpm), or 53.0 cubic meters per second (m^3/s). Two shoreline intake structures, one for each unit, are located along the eastern shore of the Hudson River on the northwestern edge of the site and provide cooling water to IP2 and IP3. Each structure consists of seven bays, six for circulating water and one for service water. IP2 also uses service water withdrawn from the former IP1 intake, located along the shoreline between the IP2 and IP3 intakes. The IP2 intake structure has seven independent bays, while the IP3 intake structure has seven bays that are served by a common plenum. In each structure, six of the seven bays contain cooling water pumps, and the seventh bay contains service/auxiliary water pumps. Before it is pumped to the condensers, river water passes through traveling screens in the intake structure bays to remove debris, fish and other aquatic life.

The six IP2 circulating water intake pumps are dual-speed pumps. When operated at high speed (254 revolutions per minute (rpm)), each pump provides 312 cfs (140,000 gpm; 8.83 m3/s) and a dynamic head of 21 ft (6.4 m). At low speed (187 rpm), each pump provides 38 cfs (84,000 gpm; 5.30 m^3/s) and a dynamic head of 15 ft (4.6 m). The six IP3 circulating water intake pumps are variable-speed pumps. When operated at high speed (360 rpm), each pump provides 312 cfs (140,000 gpm; 8.83 m^3/s); at low speed, it provides a dynamic head of 29 ft (8.8 m) and 143 cfs (64,000 gpm; 4.05 m^3/s).

As described in the FSEIS, Entergy adjusts the speed of the intake pumps to mitigate impacts to the Hudson River. According to Entergy, the 1980 Hudson River Settlement Agreement (HRSA) required Indian Point to be retrofitted with dual speed (at IP2) and variable speed (at IP3) pumps to allow for the reduction of cooling water intake flows to the minimum necessary for efficient plant operations. The HRSA expired in 1991, but the requirement regarding the minimization of intake flows was continued in a series of judicially approved Consent Orders, the last of which expired on February 1, 1998. Since then, Indian Point has committed to continue to operate both Units in the manner set forth in the final Consent Order until a new SPDES permit is issued. Entergy states that the factors affecting pump speed are river water temperature, plant operating status, and the need to manage flow rates to comply with water quality standards or other SPDES permit conditions.

Each coolant pump bay is about 15 ft (4.6 m) wide at the entrance, and the bottom is located 27 ft (8.2 m) below mean sea level. Before entering the intake structure bays, water flows under a floating debris skimmer wall, or ice curtain, into the screen wells. This initial screen keeps floating debris and ice from entering the bay. At the entrance to each bay, water also passes through a subsurface bar screen (consisting of metal bars with 3 inch clear spacing) to prevent additional large debris from becoming entrained in the cooling system. At full speed, the approach velocity in front of the screens is 1 foot per second (fps); at reduced speed, the approach velocity is 0.6 fps (Entergy 2007a). As this area is behind a bulkhead it is outside the influence of river currents. Next, smaller debris and fish that pass through the trash bars are screened out using modified Ristroph traveling screens.

The modified Ristroph traveling screens consist of a series of panels that rotate continuously. The traveling screens employed by IP2 and IP3 are modified vertical Ristroph-type traveling screens installed in 1990 and 1991 at IP3 and IP2, respectively. The screens were designed in concert with the Hudson River Fishermen's Association, with screen basket lip troughs to retain water and minimize vortex stress (CHGEC 1999). As each screen panel rotates out of the intake bay, impinged fish are retained in water-filled baskets at the bottom of each panel and are carried over the headshaft, where they are washed out onto a fiberglass sluice using low-pressure sprays from the rear side of the machine. There are three different washwater sluices each associated with the Ristroph screens at IP2 and IP3: a fish return sluice and two debris return sluices. The fish return sluice is located on the east (descending) side of the screens near the top of the sprocket wheel and receives fish as the screen mesh rotates from the west (ascending) to the east side of each screen. The main debris sluice is located on the west side of each Ristroph screen and the auxiliary debris sluice is located on the east side of each screen below the fish return sluice. The two debris sluices join into one and discharges the contents into the Hudson RIver at the north (IP2) or south (IP3) end of the CWIS bulkhead in locations that minimize re-circulation of debris toward the intakes.

The 0.25-by-0.5-inch (in.) (0.635-by-1.27 centimeters (cm)) mesh is smooth to minimize fish abrasion by the mesh. Two high-pressure sprays remove debris from the front side of the machine after fish removal. From the buckets, fish return to the river via a 12-in. (30-cm) diameter sluice pipe. For IP2, the pipe extends 200 ft (61.0 m) into the river north of the IP2 intake structure and discharges at a depth of 35 ft (11 m). The sluice system is a 12-in.-diameter (30.5-cm-diameter) pipe that discharges fish into the river at a depth of 35 ft (10.7 m), 200 ft (61 m) from shore (CHGEC 1999). The IP3 fish return system discharges to the river by the northwest corner of the discharge canal.

Studies indicated that, assuming the screens continued to operate as they had during laboratory and field testing, the screens were "the screening device most likely to impose the least mortalities in the rescue of entrapped fish by mechanical means" (Fletcher 1990). It is important to note that these studies did not involve shortnose or Atlantic sturgeon or any species that is morphologically similar to sturgeon. The same study concluded that further refinements to the screens would be unlikely to greatly reduce fish kills. No monitoring is currently ongoing at IP2 or IP3 for impingement or entrainment or to ensure that the screens are operating per design standards, and no monitoring took place after the screens were installed. Additionally, there is no monitoring ongoing to quantify any actual incidental take of shortnose or Atlantic sturgeon or their prey. The proposed action under consultation, as currently defined by NRC, does not provide for any monitoring of direct or indirect effects to shortnose sturgeon.

After moving through the condensers, cooling water is discharged to the discharge canal via a total of six 96-in. (240-cm) diameter pipes. The cooling water enters below the surface of the 40-ft (12-m) wide canal. The canal discharges to the Hudson River through an outfall structure located south of IP3 at about 4.5 feet per second (fps) (1.4 meters per second (mps)) at full flow. As the discharged water enters the river, it passes through 12 discharge ports (4-ft by 12-ft each (1-m by 3.7-m)) across a length of 252 ft (76.8 m) about 12 ft (3.7 m) below the surface of the river. The increased discharge velocity, about 10 fps (3.0 mps), is designed to enhance mixing to minimize thermal impact.

The discharged cooling water is at an elevated temperature, and therefore, some water is lost because of evaporation. Based on conservative estimates, NRC estimates that this induced evaporation resulting from the elevated discharge temperature would be less than 60 cfs (27,000 gpm or 1.7 m^3/s). This loss is about 0.5 percent of the annual average downstream flow of the Hudson River, which is more than 9000 cfs (4 million gpm or 255 m^3/s). The average cooling water transient time ranges from 5.6 minutes for the IP3 cooling water system to 9.7 minutes for the IP2 system. Auxiliary water systems for service water are also provided from the Hudson River via the dedicated bays in the IP2 and IP3 intake structures. The primary role of service water is to cool components (e.g., pumps) that generate heat during operation. Secondary functions of the service water include the following:

- protect equipment from potential contamination from river water by providing cooling to intermediate freshwater systems;
- provide water for washing the modified Ristroph traveling screens; and,
- provide seal water for the main circulating water pumps.

As noted above, additional service water is provided to the nonessential service water header for IP2 through the IP1 river water intake structure. The IP1 intake structure has two redundant forebays with a coarse bar screen, each with a maximum or design flow of 10,000 gallons per minute (gpm). Each forebay has a dual flow traveling screen equipped with fine mesh screen (1/8 inch: 3.2 mm] panels. Each dual traveling screen at IP1 's intake has an estimated design through-screen velocity of less than the 0.50 feet per second (fps). The intake structure contains two 36-cfs[2] (16,000-gpm; 1.0-m^3/s) spray wash pumps. The screens are washed automatically and materials are sluiced to the Hudson River.

Based on the description of the action provided in the FEIS, no major construction is proposed by Entergy during the relicensing period. Entergy may undertake some refurbishment activities. In the FEIS, NRC indicates that Entergy may replace the reactor vessel heads and control rod drive mechanisms (CRDMs) for IP2 and IP3 during the term of the renewed license. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). There would be no in-water work and there is no indication that effects of this refurbishment activity would extend to the Hudson River. As such, no shortnose or Atlantic sturgeon would be exposed to effects of this refurbishment activity; therefore, effects of this activity are not considered further in this Opinion.

3.4 Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." IP2 and IP3 are located on a 239-acre (97-hectare) site on the eastern bank of the Hudson River in the village of Buchanan, Westchester County, New York, about 43 miles (mi) (69 kilometers [km) north of the southern tip of Manhattan, New York (Figures 1 and 2). The direct and indirect effects of the Indian Point facilities are related to the intake of water from the Hudson River and the discharge of heated effluent back into the Hudson River. The proposed actions have the potential to affect shortnose and Atlantic sturgeon in several ways: impingement or entrainment of individual sturgeon at the intakes; altering the abundance or availability of potential prey items; and, altering the riverine environment through the discharge of heated effluent and other pollutants. The action area for Unit 2 includes the trash bars and intakes used for IP2, but not those used for IP3. The action area for Unit 3 includes the trash bars and intakes used for IP3, but not those used for IP2. Because discharges from Units 2 and 3 mix in the same discharge canal, which leads to the river, the portion of the action area associated with the effects of discharges from each Unit cannot be identified separately for each Unit. Therefore, the combined action areas for this consultation includes the intake areas of IP1 (for service water), IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3 as described in the Effects of the Action section below.

4.0 STATUS OF THE SPECIES

We have determined that the actions considered in the Opinion may adversely affect the following listed species:

Common name	Scientific name	ESA Status
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
GOM DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Threatened
New York Bight DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
Chesapeake Bay DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered

This section presents biological and ecological information relevant to formulating the Biological Opinion. Information on the species' life history, its habitat and distribution, and other factors necessary for its survival are included to provide background for analyses in later sections of this opinion. This section reviews the status of the species rangewide as well as the status of the species in the Hudson River where the action takes place.

4.1 Shortnose Sturgeon

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, isopods), insects, and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Individual shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[3] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female and a mean of 11,568 eggs/kg body weight (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Dispersal rates differ at least regionally, laboratory studies on Connecticut River larvae indicated dispersal peaked 7-12 days after hatching in comparison to Savannah River larvae that had longer dispersal rates with multiple, prolonged peaks, and a low level of downstream movement that continued throughout the entire larval and early juvenile period (Parker 2007). Synder (1988) and Parker (2007) considered individuals to be juvenile when they reached 57mm TL. Laboratory studies demonstrated that larvae from the Connecticut River made this transformation on day 40 while Savannah River fish made this transition on day 41 and 42 (Parker 2007).

The juvenile phase can be subdivided in to young of the year (YOY) and immature/ sub-adults. YOY and sub-adult habitat use differs and is believed to be a function of differences in salinity tolerances. Little is known about YOY behavior and habitat use, though it is believed that they are typically found in channel areas within freshwater habitats upstream of the salt wedge for about one year (Dadswell et al. 1984, Kynard 1997). One study on the stomach contents of YOY revealed that the prey items found corresponded to organisms that would be found in the channel

[3] For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

environment (amphipods) (Carlson and Simpson 1987). Sub-adults are typically described as age one or older and occupy similar spatio-temporal patterns and habitat-use as adults (Kynard 1997). Though there is evidence from the Delaware River that sub-adults may overwinter in different areas than adults and do not form dense aggregations like adults (ERC Inc. 2007). Sub-adults feed indiscriminately; typical prey items found in stomach contents include aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Dadswell 1979, Carlson and Simpson 1987, Bain 1997).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures reach between 7-9.7ºC (44.6-49.5°F), pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 15º (46.4-59°F), and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell et al. 1984; Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kynard et al. 2012). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° (46.4°F) and 12°C (53.6°F), eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles or sub-adults tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes and move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney et al. 1992; Rogers et al. 1994; Rogers and Weber 1995; Weber 1996).

While shortnose sturgeon do not undertake the significant marine migrations seen in Atlantic sturgeon, telemetry data indicates that shortnose sturgeon do make localized coastal migrations. This is particularly true within certain areas such as the Gulf of Maine (GOM) and among rivers in the Southeast. Interbasin movements have been documented among rivers within the GOM and between the GOM and the Merrimack, between the Connecticut and Hudson rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F) (Dadswell et al. 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). However, water temperatures above 28ºC (82.4°F) are thought to adversely affect shortnose sturgeon. In the Altamaha River, water temperatures of 28-30ºC (82.4-86°F) during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. Dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m (approximately 2 feet) is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m (98.4 ft) but are generally found in waters less than 20m (65.5 ft) (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989); however, shortnose sturgeon forage on vegetated mudflats and over shellfish beds in shallower waters when suitable forage is present.

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were "in peril…gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[4] of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and

[4] The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (2005) also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, United States Geological Survey, personal communication; Dionne 2010), while the largest populations are found in the Saint John (~18, 000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species population rangewide, or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery rangewide
The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel et al. 1992; Collins et al. 1996). In-water or nearshore construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to riverine habitat which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e. PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC. Flourney et al.(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney et al.1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (82.4°F) (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

4.2 Atlantic Sturgeon

The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon and then provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of which Atlantic sturgeon DPSs likely occur in the action area and provide information on the use of the action area by Atlantic sturgeon.

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott, 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). NMFS has delineated U.S. populations of Atlantic sturgeon into five DPSs (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (see Figure 1). The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King, 2011). However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies.

Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine and riverine environment that occur far from natal spawning rivers.

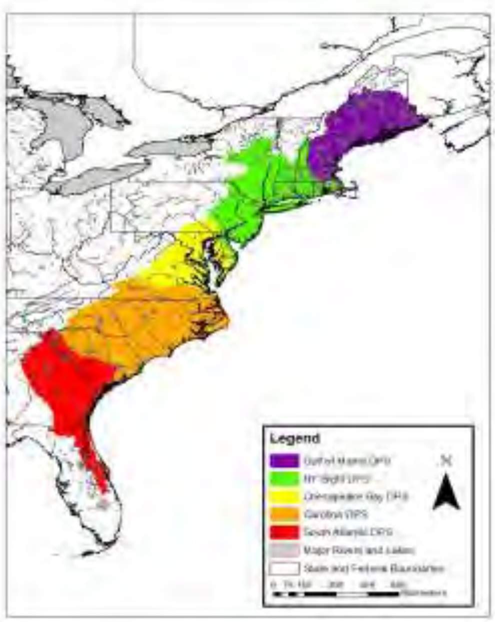
On February 6, 2012, we published notice in the *Federal Register* that we were listing the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs as endangered, and the Gulf of Maine DPS as threatened (77 FR 5880 and 77 FR 5914). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings.

As described below, individuals originating from three of the five listed DPSs are likely to occur in the action area. Information general to all Atlantic sturgeon as well as information specific to each of the relevant DPSs, is provided below.

4.2.1 Determination of DPS Composition in the Action Area

As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated. We have determined that Atlantic sturgeon in the action area likely originate from three of the five DPSs at the following frequencies: Gulf of Maine 6%; NYB 92%; and, Chesapeake Bay 2%. These percentages are based on genetic sampling of individuals (n=39) captured within the Hudson River and therefore, represent the best available information on the likely genetic makeup of individuals occurring in the action area. The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation we have selected the reported values above, which approximate the mid-point of the range, as a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail in Damon-Randall *et al.* (2012a).

Figure 1. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs



4.2.2 Atlantic sturgeon life history

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[5] fish (Bigelow and Schroeder, 1953; Vladykov and Greeley 1963; Mangin, 1964; Pikitch *et al.*, 2005; Dadswell, 2006; ASSRT, 2007).

The life history of Atlantic sturgeon can be divided up into five general categories as described in the table below (adapted from ASSRT 2007).

Age Class	Size	Description
Egg		Fertilized or unfertilized
Larvae		Negative photo-taxic, nourished by yolk sac
Young of Year (YOY)	**0.3 grams <41 cm TL**	Fish that are > 3 months and < one year; capable of capturing and consuming live food
Non-migrant subadults or juveniles	**>41 cm and <76 cm TL**	Fish that are at least age 1 and are not sexually mature and do not make coastal migrations.
Subadults	**>76cm and <150cm TL**	Fish that are not sexually mature but make coastal migrations
Adults	**>150 cm TL**	Sexually mature fish

Table 1. Descriptions of Atlantic sturgeon life history stages.

Atlantic sturgeon are a relatively large fish, even amongst sturgeon species (Pikitch *et al.*, 2005). Atlantic sturgeons are bottom feeders that suck food into a ventrally-located protruding mouth (Bigelow and Schroeder, 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder, 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand

[5] Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn (NEFSC FAQ's, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011)

lance (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007; Savoy, 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007).

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e. length) than fully mature males; and (4) the length of Atlantic sturgeon caught since the mid-late 20th century have typically been less than 3 meters (m) (Smith *et al.*, 1982; Smith *et al.*, 1984; Smith, 1985; Scott and Scott, 1988; Young *et al.*, 1998; Collins *et al.*, 2000; Caron *et al.*, 2002; Dadswell, 2006; ASSRT, 2007; Kahnle *et al.*, 2007; DFO, 2011). The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 m (Vladykov and Greeley, 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large-sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Dadswell, 2006). However, while females are prolific with egg production ranging from 400,000 to 4 million eggs per spawning year, females spawn at intervals of 2-5 years (Vladykov and Greeley, 1963; Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Stevenson and Secor, 1999; Dadswell, 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman, 1997). Males exhibit spawning periodicity of 1-5 years (Smith, 1985; Collins *et al.*, 2000; Caron *et al.*, 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (ASMFC, 2009). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco, 1977; Smith, 1985; Bain, 1997; Smith and Clugston, 1997; Caron *et al.*, 2002). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43° F) (Smith *et al.*, 1982; Dovel and Berggren, 1983; Smith, 1985; ASMFC, 2009), and remain on the spawning grounds throughout the spawning season (Bain, 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren, 1983; Smith, 1985; Collins *et al.*, 2000), make rapid spawning migrations upstream, and quickly depart following spawning (Bain, 1997).

The spawning areas in most U.S. rivers have not been well defined. However, the habitat characteristics of spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 cm/s and depths are 3-27 m (Borodin, 1925; Dees, 1961; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; Shirey *et al.* 1999; Bain *et al.*, 2000; Collins *et al.*, 2000; Caron *et al.* 2002; Hatin *et al.* 2002; ASMFC, 2009). Sturgeon eggs are deposited on hard bottom substrate such as cobble, coarse sand, and bedrock (Dees, 1961; Scott and Crossman, 1973; Gilbert, 1989; Smith and Clugston, 1997; Bain *et al.* 2000; Collins *et al.*, 2000; Caron *et al.*, 2002; Hatin *et al.*, 2002; Mohler, 2003; ASMFC, 2009), and become adhesive shortly after fertilization (Murawski and Pacheco, 1977; Van den Avyle, 1983; Mohler, 2003). Incubation time for the eggs increases as water temperature decreases (Mohler, 2003). At temperatures of 20° and 18° C, hatching occurs approximately 94 and 140 hours, respectively, after egg deposition (ASSRT, 2007).

Larval Atlantic sturgeon (i.e. less than 4 weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam *et al.* 1996) are assumed to undertake a demersal existence and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.*, 1980; Bain *et al.*, 2000; Kynard and Horgan, 2002; ASMFC, 2009). Studies suggest that age-0 (i.e., young-of-year), age-1, and age-2 juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley, 1999; Hatin *et al.*, 2007; McCord *et al.*, 2007; Munro *et al.*, 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.*, 2000). Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton, 1973; Dovel and Berggen, 1983; Waldman *et al.*, 1996; Dadswell, 2006; ASSRT, 2007).

After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 m in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley, 1963; Murawski and Pacheco, 1977; Dovel and Berggren, 1983; Smith, 1985; Collins and Smith, 1997; Welsh *et al.*, 2002; Savoy and Pacileo, 2003; Stein *et al.*, 2004; USFWS, 2004; Laney *et al.*, 2007; Dunton *et al.*, 2010; Erickson *et al.*, 2011; Wirgin and King, 2011). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 m during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 m in summer and fall (Erickson *et al.*, 2011). Shirey (Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009) found a similar movement pattern for juvenile Atlantic sturgeon based on recaptures of fish originally tagged in the Delaware River. After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras, North Carolina from November through early March. In the spring, a portion of the tagged fish re-entered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall. The majority of these tag returns were reported from relatively shallow near shore fisheries with few fish reported from waters in excess of 25 m (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia/North Carolina border to Cape Hatteras at depths up to 24 m (Dovel and Berggren, 1983; Dadswell *et al.*, 1984; Johnson *et al.*, 1997; Rochard *et al.*, 1997; Kynard *et al.*, 2000; Eyler *et al.*, 2004; Stein *et al.*, 2004; Wehrell, 2005; Dadswell, 2006; ASSRT, 2007; Laney *et al.*, 2007). These sites may be used as foraging sites and/or thermal refuge.

4.1.2 Distribution and Abundance

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and Crossman, 1973; Taub, 1990; Kennebec River Resource Management Plan, 1993; Smith and Clugston, 1997; Dadswell, 2006; ASSRT, 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware, and at least 10,000 females for other spawning stocks (Secor and Waldman, 1999; Secor, 2002). Historical records suggest that Atlantic sturgeon spawned in at least 35 rivers prior to this period. Currently, only 16 U.S. rivers are known to support spawning based on available evidence (i.e., presence of young-of-year or gravid Atlantic sturgeon documented within the past 15 years) (ASSRT, 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only four rivers (Kennebec, Hudson, Delaware, James) are known to currently support spawning from Maine through Virginia where historical records support there used to be fifteen spawning rivers (ASSRT, 2007). Thus, there are substantial gaps in the range between Atlantic sturgeon spawning rivers amongst northern and mid-Atlantic states which could make recolonization of extirpated populations more difficult.

There are no current, published population abundance estimates for any spawning stock or for any of the five DPSs of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). An estimate of 343 spawning adults per year is available for the Altamaha River, GA, based on fishery-independent data collected in 2004 and 2005 (Schueller and Peterson, 2006). Using the data collected from the Hudson River and Altamaha River to estimate the total number of Atlantic sturgeon in either subpopulation is not possible, since mature Atlantic sturgeon may not spawn every year (Vladykov and Greeley, 1963; Smith, 1985; Van Eenennaam *et al.*, 1996; Stevenson and Secor, 1999; Collins *et al.* 2000; Caron *et al.*, 2002), the age structure of these populations is not well understood, and stage to stage survival is unknown. In other words, the information that would allow us to take an estimate of annual spawning adults and expand that estimate to an estimate of the total number of individuals (e.g., yearlings, subadults, and adults) in a population is lacking. The ASSRT presumed that the Hudson and Altamaha rivers had the most robust of the remaining U.S. Atlantic sturgeon spawning populations and concluded that the other U.S. spawning populations were likely less than 300 spawning adults per year (ASSRT, 2007).

4.1.3 Threats faced by Atlantic sturgeon throughout their range

Atlantic sturgeon are susceptible to over exploitation given their life history characteristics (e.g., late maturity, dependence on a wide-variety of habitats). Similar to other sturgeon species (Vladykov and Greeley, 1963; Pikitch *et al.*, 2005), Atlantic sturgeon experienced range-wide declines from historical abundance levels due to overfishing (for caviar and meat) and impacts to habitat in the 19th and 20th centuries (Taub, 1990; Smith and Clugston, 1997; Secor and Waldman, 1999).

Based on the best available information, NMFS has concluded that unintended catch of Atlantic sturgeon in fisheries, vessel strikes, poor water quality, water availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon (77 FR 5880 and 77 FR 5914; February 6, 2012). While all of the threats are not necessarily present in the same area at the same time, given that Atlantic sturgeon subadults and adults use ocean waters from the Labrador, Canada to Cape Canaveral, FL, as well as estuaries of large rivers along the U.S. East Coast, activities affecting these water bodies are likely to impact more than one Atlantic sturgeon DPS. In addition, given that Atlantic sturgeon depend on a variety of habitats, every life stage is likely affected by one or more of the identified threats.

An ASMFC interstate fishery management plan for sturgeon (Sturgeon FMP) was developed and implemented in 1990 (Taub, 1990). In 1998, the remaining Atlantic sturgeon fisheries in U.S. state waters were closed per Amendment 1 to the Sturgeon FMP. Complementary regulations were implemented by NMFS in 1999 that prohibit fishing for, harvesting, possessing or retaining Atlantic sturgeon or its parts in or from the Exclusive Economic Zone in the course of a commercial fishing activity.

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters (DFO, 2011). Sturgeon belonging to one or more of the DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the Gulf of Maine and the New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO, 2010; Wirgin and King, 2011). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), the U.S. and Canada are currently working on a conservation strategy to address the potential for captures of U.S. fish in Canadian directed Atlantic sturgeon fisheries and of Canadian fish incidentally in U.S. commercial fisheries. At this time, there are no estimates of the number of individuals from any of the DPSs that are captured or killed in Canadian fisheries each year.

Based on geographic distribution, most U.S. Atlantic sturgeon that are intercepted in Canadian fisheries are likely to originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Individuals from all 5 DPSs are caught as bycatch in fisheries operating in U.S. waters. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Federal FMPs (NMFS NEFSC 2011) in the Northeast Region but do not have a similar estimate for Southeast fisheries. We also do not have an estimate of the number of Atlantic sturgeon captured or killed in state fisheries. At this time, we are not able to quantify the effects of other significant threats (e.g., vessel strikes, poor water quality, water availability, dams, and dredging) in terms of habitat impacts or loss of individuals. While we have some information on the number of mortalities that have occurred in the past in association with certain activities (e.g., mortalities in the Delaware and James rivers that are thought to be due to vessel strikes), we are not able to use those numbers to extrapolate effects throughout one or more DPS. This is because of (1) the small number of data points and, (2) lack of information on the percent of incidences that the observed mortalities represent.

As noted above, the NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by Northeast FMPs (NEFSC 2011). The analysis prepared by the NEFSC estimates that from 2006 through 2010 there were 2,250 to 3,862 encounters per year in observed gillnet and trawl fisheries, with an average of 3,118 encounters. Mortality rates in gillnet gear are approximately 20%. Mortality rates in otter trawl gear are believed to be lower at approximately 5%.

4.2 Gulf of Maine DPS of Atlantic sturgeon

The Gulf of Maine DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007). Spawning still occurs in the Kennebec River, and it is possible that it still occurs in the Penobscot River as well. Spawning in the Androscoggin River was just recently confirmed by the Maine Department of Marine Resources when they captured a larval Atlantic sturgeon during the 2011 spawning season below the Brunswick Dam. There is no evidence of recent spawning in the remaining rivers. In the 1800s, construction of the Essex Dam on the Merrimack River at river kilometer (rkm) 49 blocked access to 58 percent of Atlantic sturgeon habitat in the river (Oakley, 2003; ASSRT, 2007). However, the accessible portions of the Merrimack seem to be suitable habitat for Atlantic sturgeon spawning and rearing (i.e., nursery habitat) (Keiffer and Kynard, 1993). Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in the Merrimack River. Studies are on-going to determine whether Atlantic sturgeon are spawning in these rivers. Atlantic sturgeons that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT, 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the Gulf of Maine DPS as well as likely throughout the entire range (ASSRT, 2007; Fernandes, *et al.*, 2010).

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (Squiers *et al.*, 1981; ASMFC, 1998; NMFS and USFWS, 1998). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (i.e., expressing milt) in July 1994 below the (former) Edwards Dam; (2) capture of 31 adult Atlantic sturgeon from June 15,1980, through July 26,1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least 4 ripe males and 1 ripe female captured on July 26,1980; and, (3) capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (NMFS and USFWS, 1998; ASMFC 2007). The low salinity values for waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

Several threats play a role in shaping the current status of Gulf of Maine DPS Atlantic sturgeon. Historical records provide evidence of commercial fisheries for Atlantic sturgeon in the

Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers *et al.*, 1979). In 1849, 160 tons of sturgeon was caught in the Kennebec River by local fishermen (Squiers *et al.*, 1979). Following the 1880's, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. All directed Atlantic sturgeon fishing as well as retention of Atlantic sturgeon by-catch has been prohibited since 1998. Nevertheless, mortalities associated with bycatch in fisheries occurring in state and federal waters still occurs. In the marine range, Gulf of Maine DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Many rivers in the Gulf of Maine DPS have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine DPS. While some dredging projects operate with observers present to document fish mortalities, many do not. To date we have not received any reports of Atlantic sturgeon killed during dredging projects in the Gulf of Maine region; however, as noted above, not all projects are monitored for interactions with fish. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects. We are also not able to quantify any effects to habitat.

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin and Saco Rivers, these dams are near the site of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon are known to occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. While not expected to be killed or injured during passage at a dam, the extent that Atlantic sturgeon are affected by the existence of dams and their operations in the Gulf of Maine region is currently unknown. The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown; however, the documentation of an Atlantic sturgeon larvae downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie and Great Works Dams. Together these dams prevent Atlantic sturgeon from accessing approximately 29 km of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. While removal of the Veazie and Great Works Dams is anticipated to occur in the near future, the presence of these dams is currently preventing access to significant habitats within the Penobscot River. While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie and Great Works Dams affects the likelihood of spawning occurring in this river. The

Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

Gulf of Maine DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Gulf of Maine over the past decades (Lichter *et al.* 2006; EPA, 2008). Many rivers in Maine, including the Androscoggin River, were heavily polluted in the past from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

There are no empirical abundance estimates for the Gulf of Maine DPS. The Atlantic sturgeon SRT (2007) presumed that the Gulf of Maine DPS was comprised of less than 300 spawning adults per year, based on abundance estimates for the Hudson and Altamaha River riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers, 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized, adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies.

Summary of the Gulf of Maine DPS
Spawning for the Gulf of Maine DPS is known to occur in two rivers (Kennebec and Androscoggin) and possibly in a third. Spawning may be occurring in other rivers, such as the Sheepscot or Penobscot, but has not been confirmed. There are indications of increasing abundance of Atlantic sturgeon belonging to the Gulf of Maine DPS. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River, and are observed in rivers where they were unknown to occur or had not been observed to occur for many years (e.g., the Saco, Presumpscot, and Charles rivers). These observations suggest that abundance of the Gulf of Maine DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for this DPS.

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC, 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy.(Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). NMFS has determined that the Gulf of Maine DPS is at risk of becoming endangered in the foreseeable future throughout all of its range (i.e., is a threatened species) based on the following: (1) significant declines in population sizes and the protracted period during which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect recovery.

4.3 New York Bight DPS of Atlantic sturgeon

The New York Bight DPS includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, MA to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco, 1977; Secor, 2002; ASSRT, 2007). Spawning still occurs in the Delaware and Hudson Rivers, but there is no recent evidence (within the last 15 years) of spawning in the Connecticut and Taunton Rivers (ASSRT, 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT, 2007; Savoy, 2007; Wirgin and King, 2011).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800's is unknown but, has been conservatively estimated at 10,000 adult females (Secor, 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor, 2002; ASSRT, 2007; Kahnle *et al.*, 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). Kahnle *et al.* (1998; 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid 1970s (Kahnle *et al.*, 1998). A decline appeared to occur in the mid to late 1970s followed by a secondary drop in the late 1980s (Kahnle *et al.*, 1998; Sweka *et al.*, 2007; ASMFC, 2010). Catch-per-unit-effort data suggests that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980's (Sweka *et al.*, 2007; ASMFC, 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and while the CPUE is generally higher in the 2000s as compared to the 1990s. Given the significant annual fluctuation, it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s. There is currently not enough information regarding any life stage to establish a trend for the Hudson River population.

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800s indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman, 1999; Secor, 2002). Sampling in 2009 to target young-of- the year (YOY) Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 YOY, ranging in size from 178 to 349 mm TL (Fisher, 2009) and the collection of 32 YOY Atlantic sturgeon in a separate study (Brundage and O'Herron in Calvo *et al.*, 2010). Genetics information collected from 33 of the 2009 year class YOY indicates that at least 3 females successfully contributed to the 2009 year class (Fisher, 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning is still occurring in the Delaware River, the relatively low numbers suggest the existing riverine population is limited in size.

Several threats play a role in shaping the current status and trends observed in the Delaware River and Estuary. In-river threats include habitat disturbance from dredging, and impacts from historical pollution and impaired water quality. A dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron, 2009), and the river receives significant shipping traffic. Vessel strikes have been identified as a threat in the Delaware River; however, at this time we do not have information to quantify this threat or its impact to the population or the New York Bight DPS. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population.

Summary of the New York Bight DPS
Atlantic sturgeon originating from the New York Bight DPS spawn in the Hudson and Delaware rivers. While genetic testing can differentiate between individuals originating from the Hudson or Delaware river the available information suggests that the straying rate is high between these rivers. There are no indications of increasing abundance for the New York Bight DPS (ASSRT, 2009; 2010). Some of the impact from the threats that contributed to the decline of the New York Bight DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes remain significant threats to the New York Bight DPS.

In the marine range, New York Bight DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, currently available estimates indicate that at least 4% of adults may be killed as a result of bycatch in fisheries authorized under Northeast FMPs. Based on mixed stock analysis results presented by Wirgin and King (2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the New York Bight DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the New York Bight DPS. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects are also not able to quantify any effects to habitat.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the New York Bight region is currently unknown.

New York Bight DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006; EPA, 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

Vessel strikes occur in the Delaware River. Twenty-nine mortalities believed to be the result of vessel strikes were documented in the Delaware River from 2004 to 2008, and at least 13 of these fish were large adults. Given the time of year in which the fish were observed (predominantly May through July, with two in August), it is likely that many of the adults were migrating through the river to the spawning grounds. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the New York Bight DPS.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the New York Bight DPS. NMFS has determined that the New York Bight DPS is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning;

and (3) the impacts and threats that have and will continue to affect population recovery.

4.4 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, VA. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT, 2007). Based on the review by Oakley (2003), 100 percent of Atlantic sturgeon habitat is currently accessible in these rivers since most of the barriers to passage (i.e. dams) are located upriver of where spawning is expected to have historically occurred (ASSRT, 2007). Spawning still occurs in the James River, and the presence of juvenile and adult sturgeon in the York River suggests that spawning may occur there as well (Musick *et al.*, 1994; ASSRT, 2007; Greene, 2009). However, conclusive evidence of current spawning is only available for the James River. Atlantic sturgeon that are spawned elsewhere are known to use the Chesapeake Bay for other life functions, such as foraging and as juvenile nursery habitat prior to entering the marine system as subadults (Vladykov and Greeley, 1963; ASSRT, 2007; Wirgin *et al.*, 2007; Grunwald *et al.*, 2008).

Age to maturity for Chesapeake Bay DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is 5 to 19 years for Atlantic sturgeon originating from South Carolina rivers (Smith *et al.*, 1982) and 11 to 21 years for Atlantic sturgeon originating from the Hudson River (Young *et al.*, 1998). Therefore, age at maturity for Atlantic sturgeon of the Chesapeake Bay DPS likely falls within these values.

Several threats play a role in shaping the current status of Chesapeake Bay DPS Atlantic sturgeon. Historical records provide evidence of the large-scale commercial exploitation of Atlantic sturgeon from the James River and Chesapeake Bay in the 19th century (Hildebrand and Schroeder, 1928; Vladykov and Greeley, 1963; ASMFC, 1998; Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007) as well as subsistence fishing and attempts at commercial fisheries as early as the 17th century (Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007; Balazik *et al.*, 2010). Habitat disturbance caused by in-river work such as dredging for navigational purposes is thought to have reduced available spawning habitat in the James River (Holton and Walsh, 1995; Bushnoe *et al.*, 2005; ASSRT, 2007). At this time, we do not have information to quantify this loss of spawning habitat.

Decreased water quality also threatens Atlantic sturgeon of the Chesapeake Bay DPS, especially since the Chesapeake Bay system is vulnerable to the effects of nutrient enrichment due to a relatively low tidal exchange and flushing rate, large surface to volume ratio, and strong stratification during the spring and summer months (Pyzik *et al.*, 2004; ASMFC, 1998; ASSRT, 2007; EPA, 2008). These conditions contribute to reductions in dissolved oxygen levels throughout the Bay. The availability of nursery habitat, in particular, may be limited given the recurrent hypoxia (low dissolved oxygen) conditions within the Bay (Niklitschek and Secor, 2005; 2010). At this time we do not have sufficient information to quantify the extent that degraded water quality effects habitat or individuals in the James River or throughout the

Chesapeake Bay.

Vessel strikes have been observed in the James River (ASSRT, 2007). Eleven Atlantic sturgeon were reported to have been struck by vessels from 2005 through 2007. Several of these were mature individuals. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the New York Bight DPS.

In the marine and coastal range of the Chesapeake Bay DPS from Canada to Florida, fisheries bycatch in federally and state managed fisheries pose a threat to the DPS, reducing survivorship of subadults and adults and potentially causing an overall reduction in the spawning population (Stein *et al.*, 2004; ASMFC, 2007; ASSRT, 2007).

Summary of the Chesapeake Bay DPS
Spawning for the Chesapeake Bay DPS is known to occur in only the James River. Spawning may be occurring in other rivers, such as the York, but has not been confirmed. There are anecdotal reports of increased sightings and captures of Atlantic sturgeon in the James River. However, this information has not been comprehensive enough to develop a population estimate for the James River or to provide sufficient evidence to confirm increased abundance. Some of the impact from the threats that facilitated the decline of the Chesapeake Bay DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). We do not currently have enough information about any life stage to establish a trend for this DPS.

Areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in U.S. state and federally-managed fisheries, Canadian fisheries and vessel strikes remain significant threats to the Chesapeake Bay DPS of Atlantic sturgeon. Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007). The Chesapeake Bay DPS is currently at risk of extinction given (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect the potential for population recovery.

4.5 Shortnose Sturgeon in the Hudson River and the action area
The action area is limited to the reach of the Hudson River affected by the operations of IP2 and IP3, including IP1 to the extent its water intake services IP2, as described in the "Action Area" section above. As such, this section will discuss the available information related to the presence and status of shortnose sturgeon in the Hudson River and in the action area.

Shortnose sturgeon were first observed in the Hudson River by early settlers who captured them as a source of food and documented their abundance (Bain et al. 1998). Shortnose sturgeon in the Hudson River were documented as abundant in the late 1880s (Ryder 1888 in Hoff 1988). Prior to 1937, a few fishermen were still commercially harvesting shortnose sturgeon in the Hudson River; however, fishing pressure declined as the population decreased. During the late 1800s and early 1900s, the Hudson River served as a dumping ground for pollutants that lead to major oxygen depletions and resulted in fish kills and population reductions. During this same time there was a high demand for shortnose sturgeon eggs (caviar), leading to overharvesting. Water pollution, overfishing, and the commercial Atlantic sturgeon fishery are all factors that may have contributed to the decline of shortnose sturgeon in the Hudson River (Hoff 1988).

In the 1930s, the New York State Biological Survey launched the first scientific analysis that documented the distribution, age, and size of mature shortnose sturgeon in the Hudson River (see Bain et al. 1998). In the 1970s, scientific sampling resumed precipitated by the lack of biological data and concerns about the impact of electric generation facilities on fishery resources (see Bain et al. 1998). The current population of shortnose sturgeon has been documented by studies conducted throughout the entire range of shortnose sturgeon in the Hudson River (see: Dovel 1979, Hoff et al. 1988, Geoghegan et al. 1992, Bain et al. 1998, Bain et al. 2000, Dovel et al. 1992).

Several population estimates were conducted throughout the 1970s and 1980s (Dovel 1979; Dovel 1981; Dovel et al. 1992). Most recently, Bain et al. (1998) conducted a mark recapture study from 1994 through 1997 focusing on the shortnose sturgeon active spawning stock. Utilizing targeted and dispersed sampling methods, 6,430 adult shortnose sturgeon were captured and 5,959 were marked; several different abundance estimates were generated from this sampling data using different population models. Abundance estimates generated ranged from a low of 25, 255 to a high of 80,026; though 61,057 is the abundance estimate from this dataset and modeling exercise that is typically used. This estimate includes spawning adults estimated to comprise 93% of the entire population or 56,708, non-spawning adults accounting for 3% of the population and juveniles 4% (Bain et al. 2000). Bain et al. (2000) compared the spawning population estimate with estimates by Dovel et al. (1992) concluding an increase of approximately 400% between 1979 and 1997. Although fish populations dominated by adults are not common for most species, there is no evidence that this is atypical for shortnose sturgeon (Bain et al. 1998).

Woodland and Secor (2007) examined the Bain et al. (1998, 2000, 2007) estimates to try and identify the cause of the major change in abundance. Woodland and Secor (2007) concluded that the dramatic increase in abundance was likely due to improved water quality in the Hudson River which allowed for high recruitment during years when environmental conditions were right, particularly between 1986-1991. These studies provide the best information available on the current status of the Hudson River population and suggests that the population is relatively healthy, large, and particular in habitat use and migratory behavior (Bain et al. 1998).

Shortnose sturgeon have been documented in the Hudson River from upper Staten Island (RM -3 (rkm -4.8)) to the Troy Dam (RM 155 (rkm 249.5); for reference, Indian Point is located at RM 43 (rkm 69))[6] (Bain et al. 2000, ASA 1980-2002). Prior to the construction of the Troy Dam in 1825, shortnose sturgeon are thought to have used the entire freshwater portion of the Hudson River (NYHS 1809). Spawning fish congregated at the base of Cohoes Falls where the Mohawk River emptied into the Hudson. In recent years (since 1999), shortnose sturgeon have been documented below the Tappan Zee Bridge from June through December (ASA 1999-2002; Dynegy 2003). While shortnose sturgeon presence below the Tappan Zee Bridge had previously been thought to be rare (Bain et al. 2000), increasing numbers of shortnose sturgeon have been

---

[6] See Figure 3 for a map of the Hudson River with these areas highlighted.

documented in this area over the last several years (ASA 1999-2002; Dynegy 2003) suggesting that the range of shortnose sturgeon is extending downstream. Shortnose sturgeon were documented as far south as the Manhattan/Staten Island area in June, November and December 2003 (Dynegy 2003).

From late fall to early spring, adult shortnose sturgeon concentrate in a few overwintering areas. Reproductive activity the following spring determines overwintering behavior. The largest overwintering area is just south of Kingston, NY, near Esopus Meadows (RM 86-94, rkm 139-152) (Dovel et al. 1992). The fish overwintering at Esopus Meadows are mainly spawning adults. Recent capture data suggests that these areas may be expanding (Hudson River 1999-2002, Dynegy 2003). Captures of shortnose sturgeon during the fall and winter from Saugerties to Hyde Park (greater Kingston reach), indicate that additional smaller overwintering areas may be present (Geoghegan et al. 1992). Both Geoghegan et al. (1992) and Dovel et al. (1992) also confirmed an overwintering site in the Croton-Haverstraw Bay area (RM 33.5 – 38,rkm 54-61). The Indian Point facility is located approximately 8km (5 miles) north of the northern extent of this overwintering area, which is near rkm 61 (RM 38). Fish overwintering in areas below Esopus Meadows are mainly thought to be pre-spawning adults. Typically, movements during overwintering periods are localized and fairly sedentary.

In the Hudson River, males usually spawn at approximately 3-5 years of age while females spawn at approximately 6-10 years of age (Dadswell et al. 1984; Bain et al. 1998). Males may spawn annually once mature and females typically spawn every 3 years (Dovel et al. 1992). Mature males feed only sporadically prior to the spawning migration, while females do not feed at all in the months prior to spawning.

In approximately late March through mid-April, when water temperatures are sustained at 8º-9° C (46.4-48.2°F) for several days[7], reproductively active adults begin their migration upstream to the spawning grounds that extend from below the Federal Dam at Troy to about Coeymans, NY (rkm 245-212 (RM 152-131); located more than 150km (93 miles) upstream from the Indian Point facility) (Dovel et al. 1992). Spawning typically occurs at water temperatures between 10-18°C (50-64.4°F) (generally late April-May) after which adults disperse quickly down river into their summer range. Dovel et al. (1992) reported that spawning fish tagged at Troy were recaptured in Haverstraw Bay in early June. The broad summer range occupied by adult shortnose sturgeon extends from approximately rkm 38 to rkm 177 (RM 23.5-110). The Indian Point facility (at rkm 69) is located within the broad summer range.

There is scant data on actual collection of early life stages of shortnose sturgeon in the Hudson River. During a mark recapture study conducted from 1976-1978, Dovel et al. (1979) captured larvae near Hudson, NY (rkm 188, RM 117) and young of the year were captured further south near Germantown (RM 106, rkm 171). Between 1996 and 2004, approximately 10 small shortnose sturgeon were collected each year as part of the Falls Shoals Survey (FSS) (ASA 2007). Based upon basic life history information for shortnose sturgeon it is known that eggs

[7] Based on information from the USGS gage in Albany (gage no. 01359139), in 2002 mean water temperatures reached 8ºC on April 10 and 15ºC on April 20; 2003 - 8ºC on April 14 and 15ºC on May 19; 2004 - 8ºC on April 17 and 15ºC on May 11. In 2011, water temperatures reached 8°C on April 11 and reached 15°C on May 19. In 2012, water temperatures reached 8°C on March 20 and reached 15°C on May 13.

adhere to solid objects on the river bottom (Buckley and Kynard 1981; Taubert 1980) and that eggs and larvae are expected to be present within the vicinity of the spawning grounds (rkm 245-212, RM 152-131) for approximately four weeks post spawning (i.e., at latest through mid-June). Shortnose sturgeon larvae in the Hudson River generally range in size from 15 to 18 mm (0.6-0.7 inches) TL at hatching (Pekovitch 1979). Larvae gradually disperse downstream after hatching, entering the tidal river (Hoff et al. 1988). Larvae or fry are free swimming and typically concentrate in deep channel habitat (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer ad Kynard 1993). Given that fry are free swimming and foraging, they typically disperse downstream of spawning/rearing areas. Larvae can be found upstream of the salt wedge in the Hudson River estuary and are most commonly found in deep waters with strong currents, typically in the channel (Hoff et al. 1988; Dovel et al. 1992). Larvae are not tolerant of saltwater and their occurrence within the estuary is limited to freshwater areas. The transition from the larval to juvenile stage generally occurs in the first summer of life when the fish grows to approximately 2 cm (0.8 in) TL and is marked by fully developed external characteristics (Pekovitch 1979).

Similar to non-spawning adults, most juveniles occupy the broad region of Haverstraw Bay (rkm 55-64.4) RM 34-40; Indian Point is located near the northern edge of the bay) (Dovel et al. 1992; Geoghegan et al. 1992) by late fall and early winter. Migrations from the summer foraging areas to the overwintering grounds are triggered when water temperatures fall to 8°C (46.4°F) (NMFS 1998), typically in late November[8]. Juveniles are distributed throughout the mid-river region during the summer and move back into the Haverstraw Bay region during the late fall (Bain et al. 1998; Geoghegan et al. 1992; Haley 1998).

Shortnose sturgeon are bottom feeders and juveniles may use the protuberant snout to “vacuum” the river bottom. Curran & Ries (1937) described juvenile shortnose sturgeon from the Hudson River as having stomach contents of 85-95% mud intermingled with plant and animal material. Other studies found stomach contents of adults were solely food items, implying that feeding is more precisely oriented. The ventral protrusable mouth and barbells are adaptations for a diet of small live benthic animals. Juveniles feed on smaller and somewhat different organisms than adults. Common prey items are aquatic insects (chironomids), isopods, and amphipods. Unlike adults, mollusks do not appear to be an important part of the diet of juveniles (Bain 1997). As adults, their diet shifts strongly to mollusks (Curran & Ries 1937).

Telemetry data has been instrumental in informing the extent of shortnose sturgeon coastal migrations. Recent telemetry data from the Gulf of Maine indicate shortnose sturgeon in this region undertake significant coastal migrations between larger river systems and utilize smaller coastal river systems during these interbasin movements (Fernandes 2008; UMaine unpublished data). Some outmigration has been documented in the Hudson River, albeit at low levels in comparison to coastal movement documented in the Gulf of Maine and Southeast rivers. Two individuals tagged in 1995 in the overwintering area near Kingston, NY were later recaptured in

[8] In 2002, water temperatures at the USGS gage at Hastings-on-Hudson (No. 01376304; the farthest downstream gage on the river) fell to 8°C on November 23. In 2003, water temperatures at this gage fell to 8°C on November 29. In 2010, water temperatures at the USGS gage at West Point, NY (No. 01374019; currently the farthest downstream gage on the river) fell to 8°C on November 23. In 2011, water temperatures at the USGS gage at West Point, NY (No. 01374019) fell to 8°C on November 24. This gage ceased operations on March 1, 2012.

the Connecticut River. One of these fish was at large for over two years and the other 8 years prior to recapture. As such, it is reasonable to expect some level of movement out of the Hudson into adjacent river systems; however, based on available information it is not possible to predict what percentage of adult shortnose sturgeon originating from the Hudson River may participate in coastal migrations.

4.6 Atlantic sturgeon in the Hudson River and the action area

Use of the river by Atlantic sturgeon has been described by several authors. The area around Hyde Park (approximately rkm134) has consistently been identified as a spawning area through scientific studies and historical records of the Hudson River sturgeon fishery (Dovel and Berggren, 1983; Van Eenennaam *et al.*, 1996; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Habitat conditions at the Hyde Park site are described as freshwater year round with bedrock, silt and clay substrates and waters depths of 12-24 m (Bain *et al.*, 2000). Bain *et al.* (2000) also identified a spawning site at rkm 112 based on tracking data. The rkm 112 site, located to one side of the river, has clay, silt and sand substrates, and is approximately 21-27 m deep (Bain *et al.*, 2000).

Young-of-year (YOY) have been recorded in the Hudson River between rkm 60 and rkm 148, which includes some brackish waters; however, larvae must remain upstream of the salt wedge because of their low salinity tolerance (Dovel and Berggren, 1983; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Catches of immature sturgeon (age 1 and older) suggest that juveniles utilize the estuary from the Tappan Zee Bridge through Kingston (rkm 43- rkm 148) (Dovel and Berggren, 1983; Bain *et al.*, 2000). Seasonal movements are apparent with juveniles occupying waters from rkm 60 to rkm 107 during summer months and then moving downstream as water temperatures decline in the fall, primarily occupying waters from rkm 19 to rkm 74 (Dovel and Berggren, 1983; Bain *et al.*, 2000). Based on river-bottom sediment maps (Coch, 1986) most juvenile sturgeon habitats in the Hudson River have clay, sand, and silt substrates (Bain *et al.*, 2000). Newburgh and Haverstraw Bays in the Hudson River are areas of known juvenile sturgeon concentrations (Sweka *et al.*, 2007). Sampling in spring and fall revealed that highest catches of juvenile Atlantic sturgeon occurred during spring in soft-deep areas of Haverstraw Bay even though this habitat type comprised only 25% of the available habitat in the Bay (Sweka *et al.*, 2007). Overall, 90% of the total 562 individual juvenile Atlantic sturgeon captured during the course of this study (14 were captured more than once) came from Haverstraw Bay (Sweka *et al.*, 2007). At around 3 years of age, Hudson River juveniles exceeding 70 cm total length begin to migrate to marine waters (Bain *et al.*, 2000).

Atlantic sturgeon adults are likely to migrate through the action area in the spring as they move from oceanic overwintering sites to upstream spawning sites and then migrate back through the area as they move to lower reaches of the estuary or oceanic areas in the late spring and early summer. Atlantic sturgeon adults are most likely to occur in the action area from May – September. Tracking data from tagged juvenile Atlantic sturgeon indicates that during the spring and summer individuals are most likely to occur within rkm 60-170. During the winter months, juvenile Atlantic sturgeon are most likely to occur between rkm 19 and 74. This seasonal change in distribution may be associated with seasonal movements of the saltwedge and differential seasonal use of habitats.

Based on the available data, Atlantic sturgeon may be present in the action area year round. As explained above, Atlantic sturgeon in the action area are likely to have originated from the New York Bight DPS, Chesapeake Bay DPS and Gulf of Maine DPS, with the majority of individuals originating from the New York Bight DPS, and the majority of those individuals originating from the Hudson River.

4.7 Factors Affecting the Survival and Recovery of Shortnose and Atlantic sturgeon in the Hudson River

There are several activities that occur in the Hudson River that affect individual shortnose and Atlantic sturgeon. Impacts of activities that occur within the action area are considered in the "Environmental Baseline" section (Section 5.0, below). Activities that impact sturgeon in the Hudson River but do not necessarily overlap with the action area are discussed below.

4.7.1 Hudson River Power Plants

The mid-Hudson River provides cooling water to four large power plants: Indian Point Nuclear Generating Station, Roseton Generating Station (RM 66, rkm 107), Danskammer Point Generating Station (RM 66, rkm 107), and Bowline Point Generating Station (RM 33, rkm 52.8). All of these stations use once-through cooling. The Lovett Generating Station (RM 42, rkm 67) is no longer operating.

In 1998, Central Hudson Gas and Electric Corporation (CHGEC), the operator of the Roseton and Danskammer Point power plants initiated an application with us for an incidental take (ITP) permit under section 10(a)(1)(B) of the ESA.[9] As part of this process CHGEC submitted a Conservation Plan and application for a 10(a)(1)(B) incidental take permit that proposed to minimize the potential for entrainment and impingement of shortnose sturgeon at the Roseton and Danskammer Point power plants. These measures ensure that the operation of these plants will not appreciably reduce the likelihood of the survival and recovery of shortnose sturgeon in the wild. In addition to the minimization measures, a proposed monitoring program was implemented to assess the periodic take of shortnose sturgeon, the status of the species in the project area, and the progress on the fulfillment of mitigation requirements. In December 2000, Dynegy Roseton L.L.C. and Dynegy Danskammer Point L.L.C. were issued incidental take permit no. 1269 (ITP 1269). At the time the ITP was issued, Atlantic sturgeon were not listed under the ESA; therefore, the ITP does not address Atlantic sturgeon.

The ITP exempts the incidental take of two shortnose sturgeon at Roseton and four at Danskammer Point annually. This incidental take level is based upon impingement data collected from 1972-1998. NMFS determined that this level of take was not likely to reduce the numbers, distribution, or reproduction of the Hudson River population of shortnose sturgeon in a way that appreciably reduces the likelihood of shortnose sturgeon to survive and recover in the wild. Since the ITP was issued, the number of shortnose sturgeon impinged has been very low. Dynegy has indicated that this may be due in part to reduced operations at the facilities which

[9] CHGEC has since been acquired by Dynegy Danskammer L.L.C. and Dynegy Roseton L.L.C. (Dynegy), thus the current incidental take permit is held by Dynegy. ESA Section 9 prohibits take, among other things, without express authorization through a Section 10 permit or exemption through a Section 7 Incidental Take Statement.

results in significantly less water withdrawal and therefore, less opportunity for impingement. While historical monitoring reports indicate that a small number of sturgeon larvae were entrained at Danskammer, no sturgeon larvae have been observed in entrainment samples collected since the ITP was issued. While the ITP does not currently address Atlantic sturgeon, the number of interactions with Atlantic sturgeon at Roseton and Danskammer that have been reported to NMFS since the ITP became effective has been very low.

4.7.2 Scientific Studies permitted under Section 10 of the ESA

The Hudson River population of shortnose and Atlantic sturgeon have been the focus of a prolonged history of scientific research. In the 1930s, the New York State Biological Survey launched the first scientific sampling study and documented the distribution, age, and size of mature shortnose sturgeon (Bain *et al.* 1998). In the early 1970s, research resumed in response to a lack of biological data and concerns about the impact of electric generation facilities on fishery resources (Hoff 1988). In an effort to monitor relative abundance, population status, and distribution, intensive sampling of shortnose sturgeon in this region has continued throughout the past forty years. Sampling studies targeting other species, including Atlantic sturgeon, also incidentally capture shortnose sturgeon.

There are currently three scientific research permits issued pursuant to Section 10(a)(1)(A) of the ESA that authorize research on sturgeon in the Hudson River. The activities authorized under these permits are presented below.

NYDEC holds a scientific research permit (#16439, which replaces their previously held permit #1547) authorizing the assessment of habitat use, population abundance, reproduction, recruitment, age and growth, temporal and spatial distribution, diet selectivity, and contaminant load of shortnose sturgeon in the Hudson River Estuary from New York Harbor (RKM 0) to Troy Dam (RKM 245). NYDEC is authorized to use gillnets and trawls to capture up to 240 and 2,340 shortnose sturgeon in year one through years three and four and five, respectively. Research activities include: capture; measure, weigh; tag with passive integrated transponder (PIT) tags and Floy tags, if untagged; and sample genetic fin clips. A first subset of fish will also be anesthetized and tagged with acoustic transmitters; a second subset will have fin rays sampled for age and growth analysis; and a third subset will have gastric contents lavaged for diet analysis, as well as blood samples taken for contaminants. The unintentional mortality of nine shortnose sturgeon is anticipated over the five year life of the permit. This permit expires on November 24, 2016.

In April 2012, NYDEC was issued a scientific research permit (#16436) which authorizes the capture, handling and tagging of Atlantic sturgeon in the Hudson River. NYDEC is authorized to capture 1,350 juveniles and 200 adults. The unintentional mortality of two juveniles is anticipated annually over the five year life of the permit. This permit expires on April 5, 2017.

A permit was issued to Dynegy[10] in 2007 (#1580, originally issued in December 2000 as #1254 to Dynegy Danskammer, LLC and Dynegy Roseton, LLC) to evaluate the life history, population

[10] Permit 1580 was issued by NMFS to Dynegy on behalf of "other Hudson River Generators including Entergy Nuclear Indian Point 2, L.L.C., Entergy Nuclear Indian Point 3, L.L.C. and Mirant (now GenOn) Bowline, L.L.C."

trends, and spacio-temporal and size distribution of shortnose sturgeon collected during the annual Hudson River Biological Monitoring Program. This permit was reissued to Entergy in August 2012 as permit #17095; the permit will expire in 2017. The permit holders are authorized to capture up to 82 shortnose sturgeon adults/juveniles and 82 Atlantic sturgeon annually to measure, weigh, tag, photograph, and collect tissue samples for genetic analyses. The permit also authorizes the lethal take of up to 40 larvae of each species annually. No lethal take of any juvenile, subadult or adult sturgeon is authorized.

4.7.3 Hudson River Navigation Project

The Hudson River navigation project authorizes a channel 600 feet wide, New York City to Kingston narrowing to 400 feet wide to 2,200 feet south of the Mall Bridge (Dunn Memorial Bridge) at Albany with a turning basin at Albany and anchorages near Hudson and Stuyvesant, all with depths of 32 feet in soft material and 34 feet in rock; then 27 feet deep and 400 feet wide to 900 feet south of the Mall Bridge (Dunn Memorial Bridge); then 14 feet deep and generally 400 feet wide, to the Federal Lock at Troy; and then 14 feet deep and 200 feet wide, to the southern limit of the State Barge Canal at Waterford; with widening at bends and widening in front of the cities of Troy and Albany to form harbors 12 feet deep. The total length of the existing navigation project (NYC to Waterford) is about 155 miles. The only portion of the channel that is regularly dredged is the North Germantown and Albany reaches. Dredging is scheduled at times of year when sturgeon are least likely to be in the dredged reaches; no interactions with sturgeon have been observed.

4.7.4 Tappan Zee Bridge Replacement Project

The U.S. Federal Highway Authority (FHWA), the New York Department of Transportation (DOT), the New York State Thruway Authority (NYSTA) are planning to replace the existing Tappan Zee Bridge. A Record of Decision was signed in September 2012 and construction may start as soon as Fall 2012. Construction is expected to take 5 years. We issued a Biological Opinion to FHWA, as the lead Federal agency, in June 2012. This Opinion concluded that the proposed bridge replacement project may adversely affect but was not likely to jeopardize the continued existence of shortnose sturgeon or any DPS of Atlantic sturgeon. The ITS included with the Opinion exempts the lethal take of 2 shortnose sturgeon and 2 Atlantic sturgeon (from the Gulf of Maine, New York Bight or Chesapeake Bay DPS), as well as the capture and injury of shortnose and Atlantic sturgeon from the Gulf of Maine, New York Bight and Chesapeake Bay DPS. As described in the Opinion, we anticipate injury and mortality will occur as a result of exposure to underwater noise from pile driving or capture in the dredge bucket. FHWA carried out a pile installation demonstration project in spring 2012 and no injured or dead sturgeon were observed.

4.7.5 Other Federally Authorized Actions

We have completed several informal consultations on effects of in-water construction activities in the Hudson River and New York Harbor permitted by the U.S. Army Corps of Engineers (USACE). This includes several dock and pier projects. No interactions with shortnose or Atlantic sturgeon have been reported in association with any of these projects.

We have also completed several informal consultations on effects of private dredging projects permitted by the USACE. All of the dredging was with a mechanical dredge. No interactions with shortnose or Atlantic sturgeon have been reported in association with any of these projects.

4.7.6 State Authorized Fisheries

Atlantic and shortnose sturgeon may be vulnerable to capture, injury and mortality in fisheries occurring in state waters. Information on the number of sturgeon captured or killed in state fisheries is extremely limited and as such, efforts are currently underway to obtain more information on the numbers of sturgeon captured and killed in state water fisheries. We are currently working with the Atlantic States Marine Fisheries Commission (ASMFC) and the coastal states to assess the impacts of state authorized fisheries on sturgeon. We anticipate that some states are likely to apply for ESA section 10(a)(1)(B) Incidental Take Permits to cover their fisheries; however, to date, no applications have been submitted. Below, we discuss the different fisheries authorized by the states and any available information on interactions between these fisheries and sturgeon.

American Eel

American eel (*Anguilla rostrata*) is exploited in fresh, brackish and coastal waters from the southern tip of Greenland to northeastern South America. American eel fisheries are conducted primarily in tidal and inland waters. In the Hudson River, eels between 6 and 14 inches long may be kept for bait; no eels may be kept for food (due to potential PCB contamination). Eels are typically caught with hook and line or with eel traps and may also be caught with fyke nets. Sturgeon are not known to interact with the eel fishery.

Shad and River herring

Shad and river herring (blueback herring (*Alosa aestivalis*) and alewives (*Alosa pseudoharengus*)) are managed under an ASMFC Interstate Fishery Management Plan. In 2005, the ASMFC approved a coastwide moratorium on commercial and recreational fishing for shad. In May 2009, ASMFC adopted Amendment 2 to the ISFMP for Shad and River Herring, which closes all recreational and commercial fisheries unless each state can show its fisheries are sustainable. New York has submitted a Sustainable Fishing Plan that is currently under review. The plan prohibits the taking of river herring in any state waters, except for Hudson River stocks, for which it proposes partial closure in the tributaries and a five-year commercial gillnet fishery in the lower river. Although now closed, in the past this fishery was known to capture Atlantic and shortnose sturgeon.

Striped bass

Fishing for striped bass occurs within the Hudson River. Striped bass are managed by ASMFC through Amendment 6 to the Interstate FMP, which requires minimum sizes for the commercial and recreational fisheries, possession limits for the recreational fishery, and state quotas for the commercial fishery (ASMFC 2003). Under Addendum 2, the coastwide striped bass quota remains the same, at 70% of historical levels. Data from the Atlantic Coast Sturgeon Tagging Database (2000-2004) shows that the striped bass fishery accounted for 43% of Atlantic sturgeon recaptures; however, no information on the total number of Atlantic sturgeon caught by fishermen targeting striped bass is available. No information on interactions between shortnose sturgeon and the striped bass fishery is available; however, because shortnose sturgeon can be caught in hook and line fisheries as well as in otter trawls, if this gear is used in areas of the river and estuary where shortnose sturgeon are present, there could be some capture of shortnose and

Atlantic sturgeon in this fishery.

4.7.7 Other Impacts of Human Activities in the Action Area

Impacts of Contaminants and Water Quality

Historically, shortnose sturgeon were rare in the lower Hudson River, likely as a result of poor water quality precluding migration further downstream. However, in the past several years, the water quality has improved and sturgeon have been found as far downstream as the Manhattan/Staten Island area. It is likely that contaminants remain in the water and in the action area, albeit to reduced levels. Sewage, industrial pollutants and waterfront development has likely decreased the water quality in the action area. Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like sturgeon are particularly vulnerable. Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979).

Principal toxic chemicals in the Hudson River include pesticides and herbicides, heavy metals, and other organic contaminants such as PAHs and PCBs. Concentrations of many heavy metals also appear to be in decline and remaining areas of concern are largely limited to those near urban or industrialized areas. With the exception of areas near New York City, there currently does not appear to be a major concern with respect to heavy metals in the Hudson River, however metals could have previously affected sturgeon.

PAHs, which are products of incomplete combustion, most commonly enter the Hudson River as a result of urban runoff. As a result, areas of greatest concern are limited to urbanized areas, principally near New York City. The majority of individual PAHs of concern have declined during the past decade in the lower Hudson River and New York Harbor.

PCBs are the principal toxic chemicals of concern in the Hudson River. Primary inputs of PCBs in freshwater areas of the Hudson River are from the upper Hudson River near Fort Edward and Hudson Falls, New York. In the lower Hudson River, PCB concentrations observed are a result of both transport from upstream as well as direct inputs from adjacent urban areas. PCBs tend to be bound to sediments and also bioaccumulate and biomagnify once they enter the food chain. This tendency to bioaccumulate and biomagnify results in the concentration of PCBs in the tissue concentrations in aquatic-dependent organisms. These tissue levels can be many orders of magnitude higher than those observed in sediments and can approach or even exceed levels that pose concern over risks to the environment and to humans who might consume these organisms. PCBs can have serious deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). PCB's may also contribute to a decreased immunity to fin rot (Dovel *et al.* 1992). Large areas of the upper Hudson River are known to be contaminated by PCBs, and this is thought to account for the high percentage of shortnose sturgeon in the Hudson River exhibiting fin rot. Under a statewide toxics monitoring program, the NYSDEC analyzed tissues from four shortnose sturgeon to determine PCB concentrations. In gonadal tissues, where lipid percentages are highest, the average PCB concentration was 29.55 parts per million (ppm; Sloan 1981) and in all tissues ranged from 22.1 to 997.0 ppm. Dovel (1992) reported that more than 75% of the shortnose sturgeon captured in his study had severe incidence of fin rot. Given that Atlantic sturgeon have similar sensitivities to toxins as shortnose sturgeon it is reasonable to anticipate that Atlantic sturgeon have been similarly affected. In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). Manufactured Gas Product (MGP) waste, which is chemically similar to the coal tar deposits found in the Connecticut River, is known to occur at several sites within the Hudson River and this waste may have had similar effects on any sturgeon present in the action area over the years.

Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

Heavy usage of the Hudson River and development along the waterfront could have affected shortnose sturgeon throughout the action area. Coastal development and/or construction sites often result in excessive water turbidity, which could influence sturgeon spawning and/or foraging ability.

The Hudson River is used as a source of potable water, for waste disposal, transportation and cooling by industry and municipalities. Rohman *et al.* (1987) identified 183 separate industrial and municipal discharges to the Hudson and Mohawk Rivers. The greatest number of users were in the chemical industry, followed by the oil industry, paper and textile manufactures, sand, gravel, and rock processors, power plants, and cement companies. Approximately 20 publicly owned treatment works discharge sewage and wastewater into the Hudson River. Most of the municipal wastes receive primary and secondary treatment. A relatively small amount of sewage is attributed to discharges from recreational boats.

Water quality conditions in the Hudson River have dramatically improved since the mid-1970s. It is thought that this improvement may be a contributing factor to the improvement in the status of shortnose sturgeon in the river. However, as evidenced above, there are still concerns regarding the impacts of water quality on sturgeon in the river; particularly related to legacy contaminants for which no new discharges may be occurring, but environmental impacts are long lasting (e.g., PCBs, dioxins, coal tar, etc.)

5.0 ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early

Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area.

As described above, the action area is limited to the area where direct and indirect effects of the Indian Point facility are experienced and by definition is limited in the Hudson River to the intake areas of IP1 (for service water), IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3. The discussion below focuses on effects of state, federal or private actions, other than the action under consideration, that occur in the action area.

5.1 Federal Actions that have Undergone Formal or Early Section 7 Consultation

The only Federal actions that occur within the action area are the operations of the Indian Point facility and research activities authorized pursuant to Section 10 of the ESA (discussed above). No Federal actions that have undergone formal or early section 7 consultation occur in the action area.

Impacts of the Historical Operation of the Indian Point Facility

IP1 operated from 1962 through October 1974. IP2 and IP3 have been operational since 1973 and 1975, respectively. Since 1963, shortnose and Atlantic sturgeon in the Hudson River have been exposed to effects of this facility. Eggs and early larvae would be the only life stages of sturgeon small enough to be vulnerable to entrainment at the Indian Point intakes (openings in the wedge wire screens are 6mm x 12.5 mm (0.25 inches by 0.5 inches); eggs are small enough to pass through these openings but are not expected to occur in the immediate vicinity of the Indian Point site.

Studies to evaluate the effects of entrainment at IP2 and IP3 occurred from the early 1970s through 1987, with intense daily sampling during the spring of 1981-1987. As reported by the NRC in its FSEIS considering the proposed relicensing of IP2 and IP3 (NRC 2011), entrainment monitoring reports list no shortnose or Atlantic sturgeon eggs or larvae at IP2 or IP3. Given what is known about these life stages (i.e., no eggs expected to be present in the action area; larvae only expected to be found in the deep channel area away from the intakes) and the intensity of the past monitoring, it is reasonable to assume that this past monitoring provides an accurate assessment of past entrainment of sturgeon early life stages. Based on this, it is unlikely that any entrainment of sturgeon eggs and larvae occurred historically.

We have no information on any monitoring for impingement that may have occurred at the IP1 intakes. Therefore, we are unable to determine whether any monitoring did occur at the IP1 intakes and whether shortnose or Atlantic sturgeon were recorded as impinged at IP1 intakes. Despite this lack of data, given that the IP1 intake is located between the IP2 and IP3 intakes and operates in a similar manner, it is reasonable to assume that some number of shortnose and Atlantic sturgeon were impinged at the IP1 intakes during the time that IP1 was operational. However, based on the information available to us, we are unable to make a quantitative assessment of the likely number of shortnose and Atlantic sturgeon impinged at IP1 during the period in which it was operational.

The impingement of shortnose and Atlantic sturgeon at IP2 and IP3 has been documented (NRC 2011). Impingement monitoring occurred from 1974-1990, and during this time period, 21 shortnose sturgeon were observed impinged at IP2. For Unit 3, 11 impinged shortnose sturgeon were recorded. At Unit 2, 251 Atlantic sturgeon were observed as impinged during this time period, with an annual range of 0-118 individuals (peak number in 1975); at Unit 3, 266 Atlantic sturgeon were observed as impinged, with an annual range of 0-153 individuals (peak in 1976). No monitoring of the intakes for impingement has occurred since 1990.

While models of the current thermal plume are available, it is not clear whether this model accurately represents past conditions associated with the thermal plume. As no information on past thermal conditions are available and no monitoring was done historically to determine if the thermal plume was affecting shortnose or Atlantic sturgeon or their prey, it is not possible to estimate past effects associated with the discharge of heated effluent from the Indian Point facility. No information is available on any past impacts to shortnose sturgeon prey due to impingement or entrainment or exposure to the thermal plume. This is because no monitoring of sturgeon prey in the action area has occurred.

6.0 CLIMATE CHANGE

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change in the action area and how listed sturgeon may be affected by those predicted environmental changes over the life of the proposed action. Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Effects of the proposed action that are relevant to climate change are included in the Effects of the Action section below (section 7.0 below).

6.1 Background Information on predicted climate change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a). Precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b); these trends have been most apparent over the past few decades.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3^{o}-5^{o}C (5^{o}-9^{o}F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2^{o}C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene *et al.* 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene *et al.* 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene *et al.* 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Hudson River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Additional information on potential effects of climate change specific to the action area is discussed below. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2^{o}C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

6.2 Species Specific Information Related to Predicted Impacts of Climate Change

6.2.1 Shortnose sturgeon

Global climate change may affect shortnose sturgeon in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers. Shortnose sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile shortnose sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, shortnose sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, for most spawning rivers there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the saltwedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Shortnose sturgeon are tolerant to water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all shortnose sturgeon life stages, including adults, may become susceptible to strandings. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species.

6.2.2 Atlantic sturgeon

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to effect the South Atlantic and Carolina DPSs. Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile Atlantic sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, Atlantic sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the saltwedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Atlantic sturgeon prefer water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all Atlantic sturgeon life stages, including adults, may become susceptible to strandings or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat.

6.3 Potential Effects of Climate Change in the Action Area

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Hudson River largely focuses on effects that rising water levels may have on the human environment. The New York State Sea Level Rise Task Force (Spector in Bhutta 2010) predicts a state-wide sea level rise of 7-52 inches by the end of this century, with the conservative range being about 2 feet. This compares to an average sea level rise of about 1 foot in the Hudson Valley in the past 100 years. Sea level rise is expected to result in the northward movement of the salt wedge. The location of the salt wedge in the Hudson River is highly variable depending on season, river flow, and precipitation so it is unclear what effect this northward shift could have. Potential negative effects of a shift in the salt wedge include restricting the habitat available for early life stages and juvenile sturgeon which are intolerant to salinity and are present exclusively upstream of the salt wedge. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shift that may occur.

Air temperatures in the Hudson Valley have risen approximately 0.5°C (0.9°F) since 1970. In the 2000s, the mean Hudson river water temperature, as measured at the Poughkeepsie Water Treatment Facility, was approximately 2°C (3.6°F) higher than averages recorded in the 1960s (Pisces 2008). However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Hudson River generally. The Pisces report (2008) also states that temperatures within the Hudson River may be becoming more extreme. For example, in 2005, water temperature on certain dates was close to the maximum ever recorded and also on other dates reached the lowest temperatures recorded over a 53-year period. Other conditions that may be related to climate change that have been reported in the Hudson Valley are warmer winter temperatures, earlier melt-out and more severe flooding. An average increase in precipitation of about 5% is expected; however, information on the effects of an increase in precipitation on conditions in the action area is not available.

Sea surface temperatures have fluctuated around a mean for much of the past century, as measured by continuous 100+ year records at Woods Hole (Mass.), and Boothbay Harbor (Maine) and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing; for example, Boothbay Harbor's temperature has increased by about 1°C since 1970. While we are not able to find predictive models for New York, given the geographic proximity of these waters to the Northeast, we assume that predictions would be similar. For marine waters, the model projections are for an increase of somewhere between 3-4°C by 2100 and a pH drop of 0.3-0.4 units by 2100 (Frumhoff *et al.* 2007). Assuming that these predictions also apply to the action area, one could anticipate similar conditions in the action area over that same time period; considering that the proposed action will occur until 2035, we could predict an increase in ambient water temperatures of 0.034-0.045 per year for an overall increase of 0.078-1.035°C .

6.4 Effects of Climate Change in the Action Area to Atlantic and shortnose sturgeon

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose and Atlantic sturgeon. IP2 could operate until 2033 and IP3 could operate until 2035; thus, we consider here, likely effects of climate change over this time period.

Over time, the most likely effect to shortnose and Atlantic sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north which would restrict the range of juvenile sturgeon and may affect the development of these life stages. Upstream shifts in spawning or rearing habitat in the Hudson River are limited by the existence of the Troy Dam (RKM 250, RM 155), which is impassable by sturgeon. Currently, the saltwedge normally shifts seasonally from Yonkers to as far north as Poughkeepsie (RKM 120, RM 75). Given that sturgeon currently have over 75 miles of habitat upstream of the salt wedge before the Troy Dam, it is unlikely that the saltwedge would shift far enough upstream to result in a significant restriction of spawning or nursery habitat. The available habitat for juvenile sturgeon could decrease over time; however, even if the saltwedge shifted several miles upstream, it seems unlikely that the decrease in available habitat would have a significant effect on juvenile sturgeon because there would still be many miles of available low salinity habitat between the salt wedge and the Troy Dam.

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations through the area as sturgeon move to spawning and overwintering grounds. There could be shifts in the timing of spawning; presumably, if water temperatures warm earlier in the spring, and water temperature is a primary spawning cue, spawning migrations and spawning events could occur earlier in the year. However, because spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of sturgeon through the action area.

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon. If sturgeon distribution shifted along with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food. Similarly, if sturgeon shifted to areas where different forage was available and sturgeon were able to obtain sufficient nutrition from that new source of forage, any effect would be minimal. The greatest potential for effect to forage resources would be if sturgeon shifted to an area or time where insufficient forage was available; however, the likelihood of this happening seems low because sturgeon feed on a wide variety of species and in a wide variety of habitats.

Limited information on the thermal tolerances of Atlantic and shortnose sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall *et al.* 2010); in the wild, shortnose sturgeon are typically found in waters less than 28°C. In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.* 2008 and Jenkins *et al.* 1993), however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, have been documented in the lab to experience mortality at temperatures of 33.7°C (92.66°F) or greater and are thought to experience stress at temperatures above 28°C. For purposes of considering thermal tolerances, we consider Atlantic sturgeon to be a reasonable surrogate for shortnose sturgeon given similar geographic distribution and known biological similarities.

Normal surface water temperatures in the Hudson River can be as high as 24-27°C at some times and in some areas during the summer months; temperatures in deeper waters and near the bottom are cooler. A predicted increase in water temperature of 3-4°C within 100 years is expected to result in temperatures approaching the preferred temperature of shortnose and Atlantic sturgeon (28°C) on more days and/or in larger areas. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters.

As described above, over the long term, global climate change may affect shortnose and Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which shortnose or Atlantic sturgeon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect shortnose and Atlantic sturgeon in the action area. While we can make some predictions on the likely effects of climate change on these species, without modeling and additional scientific data these predictions remain speculative. Additionally, these predictions do not take into account the adaptive capacity of these species which may allow them to deal with change better than predicted.

7.0 EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and occur later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects of the proposed action on listed species and their habitat in the action area within the context of the species current status, the environmental baseline and cumulative effects. The effects of the proposed action are the effects of the continued operation of IP2 and IP3 pursuant to the existing licenses and proposed renewed licenses to be issued by the NRC pursuant to the Atomic Energy Act. NRC has requested consultation on the proposed extended operation of the facilities under the same terms as in the existing licenses and existing SPDES permits.

The proposed action has the potential to affect shortnose and Atlantic sturgeon in several ways: impingement or entrainment of individual sturgeon at the intakes; altering the abundance or availability of potential prey items; and, altering the riverine environment through the discharge of heated effluent and other pollutants.

7.1 Effects of Water Withdrawal

Under the terms of the existing licenses and the proposed renewal licenses, IP2 and IP3 will continue to withdraw water from the Hudson River for cooling. Both units utilize once through cooling and will continue to use once through cooling during the extended operating period, assuming no changes are made to the proposed action. Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. According to the draft SPDES permit for the facility, the NYDEC has determined for CWA purposes that the site-specific best technology available to minimize the adverse environmental impacts of the IP cooling water intake structures is closed-cycle cooling (NYDEC 2003b). IP2 and IP3 currently operate pursuant to the terms of the SPDES permits issued by NYDEC in 1987 but administratively extended since then. NYDEC issued a draft SPDES permit in 2003. Its final contents and timeframe for issuance are uncertain, given it is still under adjudication at this time. While it is also uncertain that the facility will be able to operate under the same terms as those in its existing license and SPDES permit, NRC sought consultation on its proposal to renew the license for the facility under the same terms as the existing license and SPDES permit, which authorize once through cooling. Here, we consider the impacts to shortnose and Atlantic sturgeon of the continued operation of IP2 and IP3 with the existing once through cooling system and existing SPDES permits from now through the duration of the proposed license renewal period for IP2 and IP3 (i.e., through September 28, 2033 and December 12, 2035, respectively). But, it is important to note that changes to the effects of the action, including but not limited to changes in the effects of the cooling water system, as well as changes in other factors, may trigger reinitiation of consultation (see 50 CFR 402.16).

7.1.1 Entrainment

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects small organisms with limited swimming ability that can pass through the screen mesh, used on the intake systems. Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they can be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000 in NRC 2011). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

7.1.1.1 Entrainment of Shortnose Sturgeon

The southern extent of the shortnose sturgeon spawning area in the Hudson River is approximately RM 118 (rkm 190*),* approximately 75 miles (121 km) upstream of the Indian Point facility. The eggs of shortnose sturgeon are demersal, sinking and adhering to the bottom of the river, and, upon hatching the larvae in both yolk-sac and post-yolk-sac stages remain on the bottom of the river, primarily upstream of RM 110 (rkm 177) (NMFS 2000). Because eggs do not occur near the IP intakes, there is no probability of entrainment. Shortnose sturgeon larvae are 20mm (0.8 inches) in length at the time they begin downstream migrations (Buckley and Kynard 1995). Because of intolerance to salinity, larvae occur only in freshwater, above the salt wedge. The location of the salt wedge in the Hudson River varies both seasonally and annually, depending at least partially on freshwater input (e.g., rainfall, snow melt). In many years, the salt wedge is located upstream of the Indian Point intakes; in those years, larvae would not be expected to occur near the IP intakes as the salinity levels would be too high. However, at times when the salt wedge is downstream of the intakes, which is most likely to occur in the late summer, there is the potential for shortnose sturgeon larvae to be present in the action area. Larvae occur in the deepest water and in the Hudson River, they are found in the deep channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae grow rapidly and after a few weeks are too large to be entrained by the cooling water intake; thus, any potential for entrainment is limited to any period when individuals are small enough to pass through the openings in the mesh screens that coincide with a period when the salt wedge is located downstream of the intakes. Given the distance between the intake and the deep channel (2000 feet; 610 meters) where any larvae would be present if in the action area, larvae are unlikely to occur near the intake where they could be susceptible to entrainment.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system. IP2 and IP3 monitored entrainment from 1972 through 1987. Entrainment monitoring became more intensive at Indian Point from 1981 through 1987, and sampling was conducted for nearly 24 hours per day, four to seven days per week, during the spawning season in the spring. As reported by NRC, entrainment-monitoring reports list no shortnose sturgeon eggs or larvae at IP2 or IP3. During the development of the HCP for steam electric generators on the Hudson River, NMFS reviewed all available entrainment data. In the HCP, NMFS (2000) lists only eight sturgeon larvae collected at any of the mid-Hudson River power plants (all eight were collected at Danskammer (approximately 23 miles upstream of Indian Point), and four of the eight may have been Atlantic sturgeon). Entrainment sampling data supplied by the applicant (Entergy 2007b) include large numbers of larvae for which the species could not be determined; however, NRC has indicated that as sturgeon larvae are distinctive it is unlikely that sturgeon larvae would occur in the "unaccounted" category as it is expected that if there were any sturgeon larvae in these samples they would have been identifiable. Entergy currently is not required to conduct any monitoring program to record entrainment at IP2 and IP3; however, it is reasonable to use past entrainment results to predict future effects. This is because: (1) there have not been any operational changes that make entrainment more likely now than it was during the time when sampling took place and, (2)there have been no changes in the locations where sturgeon spawn which would increase the exposure of eggs or larvae to entrainment. Additionally, the years when intense entrainment sampling took place overlap with two of the years (1986 and 1987; Woodland and Secor 2007) when shortnose sturgeon recruitment is thought to have been the highest and therefore, the years when the greatest numbers of shortnose sturgeon larvae were available for entrainment. Reliance on the lack of observed entrainment of shortnose sturgeon during sampling at IP2 and IP3 is also reasonable given the known information on the location of shortnose sturgeon spawning and the distribution of eggs and larvae in the river.

NRC was not able to provide NMFS with any historical monitoring data from the IP1 intakes and it is not clear if any monitoring at IP1 ever occurred. However, given that the IP1 intake (used for service water for IP2) is located adjacent to the IP2 and IP3 intakes and that intake velocity and screen size is comparable to IP2 and IP3 it is reasonable to expect that the potential for entrainment of early life stages of shortnose sturgeon at the IP1 intake is comparable to the potential for entrainment of early life stages of shortnose sturgeon at the IP2 and IP3 intakes.

Based on the life history of the shortnose sturgeon, the location of spawning grounds within the Hudson River, and the patterns of movement for eggs and larvae, it is extremely unlikely that any shortnose sturgeon early life stages would be entrained at IP2 and/or IP3. This conclusion is supported by the lack of any eggs or larvae positively identified as sturgeon and documented during entrainment monitoring at IP2 or IP3. Provided that assumption is true, NMFS does not anticipate any entrainment of shortnose sturgeon eggs or larvae in the future when IP2 and IP3 are operating pursuant to their current licenses or when they are operating pursuant to their extended operating license (i.e., through September 28, 2033 and December 12, 2035, respectively). It is important to note that this determination is dependent on the validity of the assumption that none of the unidentified larvae were shortnose sturgeon. All other life stages of shortnose sturgeon are too big to pass through the screen mesh and could not be entrained at the facility. As NMFS expects that the potential for entrainment of shortnose sturgeon at the IP1 intake is comparable to IP2 and IP3, NMFS does not anticipate any entrainment of any life stage of shortnose sturgeon at the IP1 intake, as used for service water for IP2.

7.1.1.2 Entrainment of Atlantic sturgeon

In order to be entrained, Atlantic sturgeon would need to be small enough to pass through the mesh of the traveling screens (0.25-by-0.5-inch (in.) (0.635-by-1.27 centimeters (cm)). Eggs are adhesive and demersal and occur only on the spawning grounds. At hatching, Atlantic sturgeon larvae are approximately 7.8 mm TL (Smith 1980, 1981)). As described above, the location of spawning in a given year is likely dependent on the location of the salt wedge; the most recent reports of spawning have been upstream of river kilometer 112 (Van Eenennaam *et al.*, 1996; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Young-of-year (YOY) have been recorded in the Hudson River between rkm 60 and rkm 148; which, because young of year are not likely to make extensive upstream movements, indicates that spawning likely occurs upstream of these areas. Larvae must remain upstream of the salt wedge because of their low salinity tolerance (Dovel and Berggren, 1983; Kahnle *et al.*, 1998; Bain *et al.*, 2000).

As noted above, the location of the salt wedge in the Hudson River varies both seasonally and annually, depending at least partially on freshwater input. In many years, the salt wedge is located upstream of the Indian Point intakes; in those years, larvae would not be expected to occur near the IP intakes as the salinity levels would be too high. However, at times when the salt wedge is downstream of the intakes, which is most likely to occur in the late summer, there is the potential for Atlantic sturgeon larvae to be present in the action area. Like shortnose sturgeon, Atlantic sturgeon larvae occur in the deepest water and in the Hudson River, they are found in the deep channel (Taubert and Dadswell 1980; Bath et al. 1981; Kieffer and Kynard 1993). Larvae grow rapidly; at hatching larvae are within 2 mm of the size of the opening of the mesh, in a short time they are too large to be entrained by the cooling water intake. Any potential for entrainment is limited to any period when individuals are small enough to pass through the openings in the mesh screens that coincide with a period when the salt wedge is located downstream of the intakes. Given the distance between the intake and the deep channel (2,000 feet; 610 meters) where any larvae would be present if in the action area, larvae are unlikely to occur near the intake where they could be susceptible to entrainment. No Atlantic sturgeon larvae have been documented as entrained at IP2 or IP3. The nearest documentation of Atlantic sturgeon larvae to IP2 and IP3 is at the Danskammer facility, approximately 23 miles upstream.

Based on the life history of Atlantic sturgeon, the location of spawning grounds within the Hudson River, and the patterns of movement for eggs and larvae, it is extremely unlikely that any Atlantic sturgeon early life stages would be entrained at IP2 and/or IP3. This conclusion is supported by the lack of any eggs or larvae positively identified as sturgeon and documented during entrainment monitoring at IP2 or IP3. Provided that assumption is true, we do not anticipate any entrainment of shortnose sturgeon eggs or larvae in the future when IP2 and IP3 are operating pursuant to their current licenses or when they are operating pursuant to their extended operating license (i.e., through September 28, 2033 and December 12, 2035, respectively). It is important to note that this determination is dependent on the validity of the assumption that none of the unidentified larvae were Atlantic sturgeon. All other life stages of Atlantic sturgeon are too big to pass through the screen mesh and could not be entrained at the facility. As we expect the potential for entrainment of Atlantic sturgeon at the IP1 intake is comparable to IP2 and IP3, we do not anticipate any entrainment of any life stage of Atlantic sturgeon at the IP1 intake, as used for service water for IP2.

7.1.2 Impingement

Generally speaking, impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement can kill organisms immediately or contribute to death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screenwashing and fish return system that the plant operator uses. Below, NMFS considers the available data on the impingement of shortnose and Atlantic sturgeon at the facility and then considers the likely rates of mortality associated with this impingement.

Generally, impingement occurs when a fish cannot swim fast enough to escape the intake (e.g., the fish's swimming ability is overtaken by the velocity of water being sucked into the intake). A few studies have been carried out to examine the swimming ability of sturgeon and their vulnerability to impingement. Generally speaking, fish swimming ability, and therefore ability to avoid impingement and entrainment, are affected not just by the flow velocity into the intakes, but also fish size and age, water temperature, level of fatigue, ability to remain a head-first orientation into current, and whether the fish is sick or injured. As indicated below, because some of the intakes at the Indian Point facilities are fitted with Ristrophe screens that also have rotating buckets, in the specific case of Indian Point, we consider impingement to include not just the trapping of fish against the screens, but also the collection of fish in the rotating buckets.

Kynard et al. (2005) conducted tests in an experimental flume of behavior, impingement, and entrainment of yearlings (minimum size tested 280mm FL, 324mm TL), juveniles (minimum size tested 516mm FL, 581mm TL) and adult shortnose sturgeon (minimum size tested 600mmFL, 700mm TL). Impingement and entrainment were tested in relation to a vertical bar rack with 2 inch clear spacing. The authors observed that after yearlings contacted the bar rack, they could control swimming at 1 and 2 feet/sec, but many could not control swimming at 3 feet/sec velocity. After juveniles or adults contacted the rack, they were able to control swimming and move along the rack at all three velocities. During these tests, no adults or juveniles were impinged or entrained at any approach velocity. No yearlings were impinged at velocities of 1 ft/sec, but 7.7-12.5% were impinged at 2 ft/sec, and 33.3-40.0% were impinged at 3 ft/sec. The range of entrainment of yearlings (measured as passage through the rack) during trials at 1, 2, and 3 ft/sec approach velocities follow: 4.3-9.1% at 1 ft/sec, 7.1-27.8% at 2 ft/sec, and 66.7-80.0% at 3 ft/sec. From this study, we can conclude that shortnose sturgeon that are yearlings and older (at least 280mm FL) would have sufficient swimming ability to avoid impingement at an intake with velocities of 1 fps or less, as long as conditions are similar to those in the study (e.g., fish are healthy and no other environmental factors in the field, such as heat stress, pollution, and/or disease, operate to adversely affect their swimming ability).

The swimming speed that causes juvenile shortnose sturgeon to experience fatigue was investigated by Deslauriers and Kieffer (2012). Juvenile shortnose sturgeon (19.5 cm average total length) were exposed to increasing current velocities in a flume to determine the velocity that caused fatigue. Fish were acclimated for 30 minutes to a current velocity of 5 cm/sec (0.16 fps). Current velocities in the flume then were increased by 5 cm/sec increments for 30 minutes per increment until fish exhibited fatigue. Fish were considered fatigued when they were impinged on the down-stream plastic screen for a period of 5 seconds (Deslauriers and Kieffer (2012).

The current velocity that induced fatigue was reported as the critical swimming speed ("U_{crit}") under the assumption that the fish swam at the same speed as the current. The effect of water temperature on U_{crit} for juvenile shortnose sturgeon was determined by repeating the experiment at five water temperatures: 5°C, 10°C, 15°C, 20°C and 25°C. Shortnose sturgeon in this study swam at a maximum of 2.7 body lengths/second (BL/s) at velocities of 45 cm/s (1.47 fps). In this study, the authors developed a prediction equation to describe the relationship between Ucrit and water temperature. The authors report that amongst North American sturgeon species, only the pallid and shovelnose sturgeon have higher documented U_{crit} values (in BL/s) than shortnose sturgeon at any given temperature .

Boysen and Hoover (2009) conducted swimming performance trials in a laboratory swim tunnel with hatchery-reared juvenile white sturgeon to evaluate entrainment risk in cutterhead dredges. The authors observed that 80% of individuals tested, regardless of size (80-100mm TL) were strongly rheotactic (i.e., they were oriented into the current), but that endurance was highly variable. Small juveniles (< 82 mm TL) had lower escape speeds (< 40 cm/s (1.31fps)) than medium (82–92 mm TL) and large (> 93 mm TL) fish (42–45 cm/s (1.47 fps)). The authors concluded that the probability of entrainment of juvenile white sturgeon could be minimized by maintaining dredge head flow fields at less than 45 cm/s (1.47 fps).

Hoover et al. (2011) used a Blazka-type swim tunnel, to quantify positive rheotaxis (head-first orientation into flowing water), endurance (time to fatigue), and behavior (method of movement) of juvenile sturgeon in water velocities ranging from 10 to 90 cm/s (0.3-3.0 fps). The authors tested lake and pallid sturgeon from two different populations in the U.S. Rheotaxis, endurance, and behavioral data were used to calculate an index of entrainment risk, ranging from 0 (unlikely) to 1.00 (inevitable), which was applied to hydraulic models of dredge flow fields. The authors concluded that at distances from the draghead where velocity had decreased to 40cm/s (1.31 fps) entrainment was unlikely.

7.1.2.1 Impingement of Shortnose Sturgeon at Indian Point

Impingement of most fish species at IP2 and IP3 was monitored daily until 1981. Impingement of sturgeon species was monitored daily from 1974-1990 (Entergy 2009). Collections were reduced to a randomly selected schedule of 110 days per year until 1991, and then monitoring ceased in 1991 with the installation of the modified Ristroph traveling screens. All historic monitoring occurred at the Ristroph screens. No monitoring of impingement at the trash racks has ever occurred and we have no reports of any past impingement of sturgeon at the IP1, IP2 or IP3 trash racks; however, this lack of reported impingement at the trash racks is due to a lack of monitoring, not necessarily a lack of actual impingements. For reasons described below, we believe impingements occur at the trash racks.

After NRC submitted its 2008 BA, Entergy submitted revised impingement data to NRC to correct certain accounting errors related to sampling frequency. The corrected impingement data for shortnose sturgeon, presented in NRC's 2010 BA, is summarized below (Table 2). The actual observed number of impingements is recorded as "Observed Fish" below (called the Level 5 Count in NRC 2010 and 2012). This number was adjusted to account for collection efficiency to determine the "Estimated Fish" below (the "CE Adjusted Level 5 Count" in NRC 2010 and 2012).

A total of 32 shortnose sturgeon were observed during impingement monitoring at IP2 and IP3 from 1974-1990. Adjusting for collection efficiency, it is estimated that a total of 71 shortnose sturgeon were impinged at IP2 and IP3 during this period. For this period, the average number of shortnose sturgeon impinged per year at IP2 and IP3 was 4.2 shortnose sturgeon/year (see Table 2 below).

Table 2. Actual and Adjusted Level of Annual Impingement of Shortnose Sturgeon 1974-1990

	IP2		***IP3***		
Year	**Observed Fish**	**Estimated Fish**	**Observed Fish**	**Estimated Fish**	**Total IP2 and IP3 Annual Estimate**
1974	3	9	0	0	9
1975	1	3	NR	NR	3*
1976	1	2	0	0	2
1977	5	11	1	2	13
1978	2	5	3	5	10
1979	2	4	2	3	7
1980	0	0	1	2	2
1981	0	0	0	0	0
1982	0	0	0	0	0
1983	0	0	0	0	0
1984	1	3	1	2	5
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	2	4	1	2	6
1988	3	7	1	2	9
1989	0	0	1	2	2
1990	1	3	0	0	3
Total	21	**51**	11	**20**	**71**

In addition to the withdrawal of water from the IP2 and IP3 intakes for cooling water and service water, additional service water for IP2 is withdrawn through the IP1 intakes. This intake is located between the IP2 and IP3 intakes, also along the eastern shore of the Hudson River. NRC was not able to provide NMFS with any monitoring data from IP1 and it is unclear if any monitoring at IP1 has ever occurred. As such, we have no reports of impingement at IP1 and none of the materials submitted by NRC or Entergy have contained an estimate of impingement at IP1. For reasons discussed below, we believe impingement occurs at the intakes for IP2 (which includes the IP1 intake providing service water for IP2) and IP3

Following the reinitiation of consultation in 2012, Entergy provided us with a report on shortnose and Atlantic sturgeon impingement at Indian Point (Entergy 2012). According to the report, Entergy has made the assumption that the likelihood of impingement is related to the amount of water withdrawn. This seems to be a reasonable assumption as the more water that is withdrawn through the intakes the greater the opportunity is for fish to be drawn into the intakes and impinged. Entergy reports that the amount of water withdrawn varies seasonally and annually. They suspect that these differences could account for some of the interannual variability in impingement of sturgeon. To account for interannual variations in operations, Entergy calculated an "impingement density" of sturgeon; that is, the number of sturgeon/volume of water withdrawn (cooling plus service water). This value was calculated using the adjusted impingement values (Estimated Fish in the table above) from 1976-1990 and the actual water withdrawal rates from IP2 and IP3 during the same period. Monthly average impingement densities were estimated by dividing the total number of sturgeon impinged during that month by the actual average withdrawal rate (gpm x 106) for the month (Entergy 2012). Using this method, Entergy determined that on average during 1976-1990, the highest impingement occurred in April (approximately 1 per month), with the lowest impingement (none) occurring in the June, July or December. In other months, the average was less than one per month.

Impingement density values are shown for each year 1976 through 1990[11] for shortnose sturgeon in Figure 2. This figure presents year on the horizontal axis and the vertical axis shows the annual sturgeon impingement density (sturgeon per million gpm) for IP2 and IP3 combined. The annual sturgeon impingement density shown on the vertical axis of Figure 2 is calculated as the annual number (count) of sturgeon impinged and then scaled upward by monthly collection efficiency values for each Unit in each year and divided by the annual average cooling water withdrawal rate for that Unit and year in million gallons per minute. The impingement density values plotted on the vertical axis in Figure 3 represents the sum of each density value for IP2 and IP3 for each year.

Annual shortnose sturgeon impingement density (average of monthly estimates of impingement density based on number impinged and the average monthly flow rate) ranged from 0 (1981, 1982, 1983, 1985 and 1986) to 2.1 (1977). These are also the years with the lowest and highest estimated total impingement (see Table above).

[11] Entergy used the years 1976-1990 for this method because those were the years that flow data was available. Also, IP3 was not operational in 1975.

Figure 2. Among year pattern of shortnose sturgeon impingement density at IP2 and IP3 (combined). Annual density is the average of monthly estimates of impingement density based on number impinged and the average monthly flow rate (million gpm). From Entergy 2012.

Figure 3. Among-month pattern of average shortnose sturgeon impingement at IP2 and IP3, and average IP flows (cooling water plus service water) for the years 1976-1990.

These calculations suggest that there may be factors other than water withdrawal volume that contributed to the number of sturgeon impinged at IP2 and IP3. For example, according to the information presented in Figure 3, June and July (months 6 and 7) are two of the months with the highest amount of water withdrawal, yet there is an average of zero impingements during these months. We would also expect that if the volume of water withdrawn was the only factor associated with impingement, there would be very little variability in impingement density from one year to the next. As demonstrated in Figure 2 there is substantial variability in impingement density from year to year.

Possible explanations for monthly and annual differences in impingement density include environmental conditions (e.g., water temperature, availability of forage, location of the salt wedge) that would influence the likelihood of shortnose sturgeon presence in the action area as well as changes in the number of sturgeon in the action area due to the strength of various year classes and overall size of the population. We do not have data on water temperature, availability of forage, location of the salt wedge, or other possible factors that might explain the differences, for the time period that impingement monitoring occurred; therefore we are not able to explore any of these possible explanations. As discussed in more detail below, shortnose sturgeon in the Hudson River experienced an increasing trend over the time period that impingement monitoring occurred. We would expect that there would also be an increasing trend in impingement due to the presence of a greater number of shortnose sturgeon in the Hudson River, particularly after 1985; however, this is not seen.

Predicted Future Impingement of Shortnose Sturgeon

We anticipate impingement of shortnose sturgeon at the IP1, IP2 and IP3 intakes. In front of all three intakes there are trash bars with 3-inch spacing between them. Entergy reports that the intake water approach velocity 3-12 inches upstream from the bar racks at IP2 and IP3 was estimated at mean low water to be 1.0 fps for 100% circulating water flow (840,000 gpm) and 0.6 fps for 60% reduced circulating water flow (504,000 gpm) (see Entergy 2007). Fish that are narrower than 3-inches can pass through the trash bars. Fish wider than 3-inches would be impinged on the trash racks if they were not able to swim away. Once inside the trash racks, fish that do not swim back out through the racks into the river would be impinged at the screens in front of the intakes or captured in the moving buckets that are part of the Ristroph screens.

At IP2 and IP3 there are modified Ristroph traveling screens. Fletcher (1990) reports that the mean water velocity in the area between the trash rack and the traveling screens was 30cm/second (0.98 feet/second) and varied with the tide during testing of the screens carried out in 1986. Fletcher (1990) does not report the range of velocities that are experienced in this area. Entergy reports that the velocity through the Ristroph traveling screens at mean low water has been calculated to be 1.6 fps for 100% circulating water flow rate and 1.0 fps for 60% circulating water flow rate. The traveling screens continually move vertically through the water column as they rotate. The Ristroph screens have a screen basket equipped with a water-filled lifting bucket. Fish can be forcibly impinged on the screens or can be captured by the buckets. Fish can also be impinged on the screen and then fall off it into the buckets. As each bucket passes over the top of the screen, fish are rinsed into a collection trough by a spraywash system. For the purposes of this Opinion, we are characterizing "impingement" as both forcible impingement on the trash racks or screens at any of the intakes (i.e., getting stuck and not being able to swim away) and capture in the Ristroph screen buckets.

Impingement of shortnose sturgeon at the trash racks

If through-rack velocity at the trash racks in front of IP1, IP2 and IP3 is 1.0 fps, as reported by Entergy, and assuming the condition of the fish and environmental factors in the river are similar to those in the laboratory studies previously discussed, we would not anticipate any impingement of shortnose sturgeon at the trash racks, because sturgeon that are big enough to not be able to pass through the racks (i.e., those that have body widths greater than three inches) would be adults. If their swimming ability is not compromised, these fish should be able to avoid impingement at velocities of up to 3 feet per second and should be able to readily avoid getting stuck on the trash racks. The only impingement at the trash racks that we anticipate is adult or large juvenile shortnose sturgeon that are dead or stressed and, therefore, unable to avoid the current caused by the facility's water intake and swim away from the trash racks. We know sturgeon (whether dead or alive) are present at the trash bars given that the smaller individuals have to pass through them to get to the screens, and both smaller and larger individuals use this part of the Hudson. Therefore, we expect the larger individuals that are too large to pass through the bars, yet unable to swim away from them, will be impinged on them. While we expect shortnose sturgeon will be impinged at the trash racks, the cause of death/stressor is currently unknown. However, impingement on the trash bars, at a minimum, would be "capture" or "collection" under the ESA's definition of "take." As noted above, there has been no past monitoring of impingement of any species, including shortnose sturgeon, at the trash racks. Therefore, there is no information from which to predict a future impingement estimate. We considered estimating impingement based on impingement of shortnose sturgeon at other power plants, however there are no comparable facilities. Therefore, we are unable to predict the number of dead or stressed shortnose sturgeon that are likely to be impinged at IP1, IP2 or IP3 trash racks during the continued operation of IP2 and IP3.

Impingement of shortnose sturgeon at the intake screens

Entergy and Fletcher (1990) both report that velocities in front of the traveling screens are on average 1.0 fps or less. The laboratory studies on sturgeon swimming ability discussed in Section 7.1.2 indicate that shortnose sturgeon older than one year and larger than 28cm long should be able to avoid impingement, assuming similar conditions in the river as in the laboratory. The Kynard study suggest that impingement rates for yearlings would be less than 10% at this intake velocity.

We examined the available data on shortnose sturgeon impinged at IP2 and IP3 to determine the length of impinged fish. Of the 32 shortnose sturgeon recorded at IP2 and IP3 from 1974-1990, length is available for only nine individuals. These fish ranged in size from 32-71 cm. This is consistent with our estimates of the size of fish that would be able to pass through the trash bars but is larger than the size of fish we would expect to be vulnerable to impingement if the flow velocity is 1 fps.

Entergy applied the prediction equation for U_{crit} as a function of water temperature (from Deslauriers and Kieffer 2012) to the range of monthly water temperatures in the vicinity of IP2 and IP3 to estimate the minimum size of sturgeon that would have a U_{crit} swimming speed greater than the through-screen velocity and therefore should be able to avoid impingement at IP2 and IP3 (Entergy 2012). In the equation, the through-screen intake velocity was assumed to be 1.0 ft/sec for full flow conditions and 0.6 ft/sec for reduced flow conditions (Enercon 2010); these are the velocities measured 3-12 inches upstream from the bar racks during these flow conditions (see Entergy 2007). Based on the average historical flows at IP2 and IP3 (Figures 2 and 3), Entergy assumed that full flow conditions might exist from May through October, and reduced flow conditions would exist from November through April.

The results of Entergy's analysis indicate that healthy sturgeons over 19.5 cm TL should be capable of sustained avoidance of impingement at IP2 and IP3 throughout the year. Entergy states that these results may be conservative. In an earlier study, Kieffer et al. (2009) measured U_{crit} values for juvenile shortnose sturgeon ranging in length from 14 to 18 cm TL at a temperature of 15°C. These authors estimated U_{crit} at this temperature to be 2.18 BL/sec. Assuming this value, any shortnose sturgeon longer than 14.0 cm TL would be able to avoid impingement during the months of May through September, when the average water temperature at Indian Point is equal to or greater than 15°C.

Based on the size of the shortnose sturgeon that have been impinged at IP2 and IP3 and the analysis completed by Entergy, it appears that there are other factors than the size of the fish that are contributing to the likelihood of impingement. It is possible that the configuration of the buckets on the traveling screen results in the capture of sturgeon prior to them getting "stuck" on the screens. This would explain why fish of a size that should be able to avoid impingement on the traveling screens have been documented during impingement sampling. It is interesting to note that Fletcher (1990) reports that striped bass are capable of sustained swimming at the flow speeds (mean 30cm/s) in front of the Ristroph screens yet during sampling at one intake bay in September and October 1986, 86 striped bass were documented as impinged (as determined by observation of individuals in the fish return sluice or the debris return sluice). Fletcher (1990) reports that the vast majority of these striped bass were not dead or dying upon collection. Of the 86 individuals, 2 were "damaged" and 5 were dead when collected. Fletcher suggests that freely swimming fish will still encounter the collection troughs with the likelihood of encounter increasing with the length of time that the fish spends in the collection area.

Another possible explanation for the impingement of shortnose sturgeon that should be of sufficient size to avoid impingement at the reported intake velocities is that these fish are impaired prior to impingement. Fish that are stressed, sick or injured may have reduced swimming speed or endurance and may not be able to avoid impingement the way a healthy fish would. Unfortunately, the data that are available on the 32 impinged shortnose sturgeon only indicate condition (alive or dead) for nine individuals. We examined the available information to see if there was a relationship between the length of these nine fish and whether they were alive or dead, and there did not appear to be a relationship between size and condition.

It is also possible that fish that pass through the trash bars become stressed, tired or disoriented when trying to find an escape route. Even if through-rack velocity is not high enough to preclude fish from exiting the area, they may have difficulty finding a way out, especially if there is debris in front of the trash bars. Information presented by Fletcher (1990) on the length of time that fish spent in the area between the trash racks and the Ristroph screens supports this idea; for marked striped bass during a release-recapture study at Indian Point, the mean time spent in the area between the trash racks and Ristroph screens prior to observation in the fish return sluice was 9.73 hours. Some fish may swim into the area between the trash bars and the Ristroph screens and swim away without any injury or impairment of normal behaviors. We expect any fish that remain in this area long enough to become stressed, tired or disoriented would become impinged on the Ristroph screens or captured in the traveling buckets.

We have considered whether the thermal plume may affect shortnose sturgeon in a way that increases the potential for impingement (see 7.2.1, below) and have determined that based on the available information on the thermal plume, it is not likely that the thermal plume directly influences impingement of sturgeon. The impingement of sturgeon at IP2 and IP3 is probably due to a combination of the factors mentioned above, all of which explain how impingement can occur despite intake velocities at levels that are below those that most sturgeon should be able to readily escape from. The lack of information on the condition of the impinged shortnose sturgeon makes it difficult to draw any conclusions about other factors that may contribute to impingement, including the impact of the thermal plume on the swimming endurance of sturgeon near the intake. Despite the low intake velocity reported by Entergy, impingement of sturgeon occurred in the past and likely continues to occur. The lack of recent monitoring data makes predictions of future impingement more difficult. Estimating future impingement is made more difficult by the variability in annual impingement rates and not knowing the degree to which factors discussed above contribute to these differences. We have considered several ways to estimate likely future impingement including: (1) using the annual average number of impingements to predict future impingement; and (2) using Entergy's impingement density calculations.

Calculations based on Impingement data from 1974-1990

During the period that impingement sampling occurred, the number of shortnose sturgeon impinged ranged from zero to 13. The average annual impingement was 4.2 shortnose sturgeon/year. Excluding 1975, when only IP2 was operational, the average was 4 per year. As noted in the Status of the Species section of this Opinion, the shortnose sturgeon population has grown since the time impingement monitoring ceased. Therefore, we considered if the average impingement rate during 1974-1990 would underestimate future impingement.

We have made the basic assumption that the risk of impingement increases with the size of the population. That is, we expect that if there are more fish in the river there is more opportunity for individuals to be impinged. We expect if there are more sturgeon in the action area then the impingement rate would be higher. The shortnose sturgeon population in the Hudson River exhibited tremendous growth in the 20 year period between the late 1970s and late 1990s, with exceptionally strong year classes between 1986-1992 thought to have led to resulting increases in the subadult and adult populations sampled in the late 1990s (Woodland and Secor 2007). According to data presented by Bain (2000) and Woodland and Secor (2007), there were 4 times as many shortnose sturgeon in the Hudson River in the late 1990s as compared to the late 1970s. An increasing trend is also observed in the juvenile index of shortnose sturgeon (prepared by

NYDEC) and the CPUE of the utilities Long River and Fall Shoals Survey (Mattson 2012). Woodland and Secor (2007) state that the population of shortnose sturgeon is currently stable at the high level described also by Bain (2000).

The period for which impingement sampling occurred (1974-1990) partially overlaps with the period of increased recruitment. During the portion of the sampling period that overlaps with the period of increased recruitment (1986-1990) the increases in the shortnose sturgeon population would have been fish less than 4 years old. Those are the year classes that would be most vulnerable to impingement. As such, we would expect a peak in impingement numbers from 1986-1990; however, such a peak is not seen in the data that is available to us. In fact, average impingement from 1986-1990 is just slightly higher (five fish per year, collectively at IP2 and IP3) as compared to the 17-year average, and is lower than the average from 1976-1980 (7.4 fish/year collectively at IP2 and IP3) and two of the years (1985 and 1986) had no impingement. One possible explanation is that the fish being impinged are not the small fish (yearlings) that we expect (see above), so even if there was an increase in the number of yearling shortnose sturgeon during this period that may not be reflected in the impingement numbers. It is also possible that while there was an increase in the number of yearlings from 1986-1990 as compared to earlier years, the size of the total population was not significantly different. This could be the case as shortnose sturgeon are long-lived fish, and there are expected to be at least 20-30 year classes in the river at one time. Another explanation is that the location of the salt wedge during 1986-1990 or a subset of those years precluded or minimized the use of the action area by juvenile shortnose sturgeon, which could also affect the impingement rate; however, we do not have the information necessary to investigate that hypothesis as salt wedge location data are only available since 1990.

Entergy conducted an analysis to determine if there was a statistically significant correlation between reported shortnose sturgeon population size and impingement density. It is expected that the more sturgeon there were in the river, the higher the impingement density would be because there would be more sturgeon that had the potential to be impinged. However, the analysis does not reveal a statistically significant correlation (Entergy 2012). It is likely that this lack of statistical correlation is not due to the fact that there is no relationship between population size and impingement but because impingement of sturgeon is a rare event which makes detection of a statistically significant correlation difficult.

As noted above, one factor that may affect the likelihood of impingement is the condition of fish prior to impingement, which may dilute the relationship between numbers of fish in the river and impingement rates. Factors that have changed over time that could be related to the condition of fish in the action area include water quality, and bycatch in the direct Atlantic sturgeon fishery and the American shad fishery. The directed fishery for Atlantic sturgeon occurred until 1996. Because impingement monitoring was discontinued after 1990, we are not able to make any comparisons of impingement rates during years when fishing was occurring and years it was not. We also do not have any information on the intensity of fishing effort over time or the bycatch rate of shortnose sturgeon that we could use to compare to the impingement rates at IP2 or IP3. Similarly, we do not have the necessary information on the shad fishery to compare to the impingement rates. We do know that, generally, water quality improved significantly in the Hudson River beginning in the mid-1970s. This improvement is considered by Woodland and

Secor to be one of the primary factors contributing to the increase in the shortnose sturgeon population. It is possible that improvements in water quality resulted in an improvement of the general health of sturgeon in the action area which could have contributed to a reduction in impingement despite an increase in the number of shortnose sturgeon in the action area. Similarly, a reduction in fishing effort could lead to a reduction in bycatch and subsequent release of injured or stressed fish. However, all of this is speculative.

Other factors that may explain interannual variability in impingement numbers that are not related to absolute population size are environmental conditions in the river that are associated with the distribution of shortnose sturgeon. As established above, younger, smaller sturgeon are most likely to be vulnerable to impingement. These fish are restricted to the area of the river above the salt-freshwater interface. In some years, the saltwedge is located downstream of the Indian Point intakes and in some years it is above the Indian Point intakes. In years when the saltwedge is located further upstream, impingement would be expected to be low because, regardless of the total number of shortnose sturgeon in the river at that time, there would be few, if any, juveniles in the action area. The salt front (100 milligrams per liter of chloride) ranges from below Hastings-on-Hudson to New Hamburg during most years, but can move as far north as Poughkeepsie during periods of drought. As such, in drier periods, when the salt front is above Buchannan, we would anticipate that very few juvenile sturgeon would be present in the action area. Unfortunately, the available data on the location of the salt front in the Hudson River (October 1991 – March 2012; USGS 2012), do not overlap at all with the period of time for which impingement data is available. Therefore, we are unable to test this hypothesis regarding relationship between salt wedge location and impingement.

We considered reviewing impingement data for other Hudson River power plants to determine if this predicted correlation between increases in population size and increased impingement of individuals would be observed. Long term shortnose sturgeon impingement monitoring is only available for the Roseton and Danskammer facilities. However, since 2000, both facilities have operated at reduced rates and there has been minimal shortnose sturgeon impingement; in every year it has been less than the 2 and 4 impingements estimated respectively for these two facilities. As the Roseton and Danskammer facilities are not currently operating in the same capacity they were in the past, it is not possible to make an accurate comparison of past and present impingement which could serve to determine if it was reasonable to assume that an increase in impingement would occur in association with an increase in the number of shortnose sturgeon in the Hudson River. As noted above, the Lovett facility has been closed. The Bowline facility has always operated with extremely low levels of impingement, thought to be primarily due to the location of the intakes in a nearly enclosed embayment of the River where shortnose sturgeon are thought to be unlikely to occur (Bowline Pond) (NMFS 2000). Therefore, we are not able to use information from other power intakes to determine if there is an association between changes in population size and rates of impingement.

We also considered examining relationships between population trend and impingement rates at facilities outside the Hudson River. Monitoring of sturgeon impingement at the Salem Nuclear Generating Station, on the Delaware River, has been ongoing since 1978. However, the population of shortnose sturgeon in the Delaware River has been stable at approximately 12,000 adults since 1981. The impingement rate has similarly been stable at an average of less than one fish per year throughout this period. Because of the stable trend in the population and the impingement rate at this facility, it is not possible to use this information to determine if changes in population size are related to changes in impingement rates.

Despite the uncertainty in determining the factors that are related to impingement, the assumption that the more sturgeon there are in the river the higher the potential for impingement, is reasonable. If we adjust the average number of shortnose sturgeon impinged annually at IP2 and IP3 by 400% (the increase in the size of the population reported by Bain and Woodland and Secor), we would anticipate the impingement of an average of 16 shortnose sturgeon per year at IP2 and IP3 (combined) during the period that these facilities will continue to operate (i.e., 1974-1990 annual average was 4, times 4 = 16). From September 28, 2033 – December 12, 2035, only IP3 will be operational. During the period 1974-1990, approximately 28% of the impinged shortnose sturgeon were at IP3. Using that ratio and applying it to the estimate of 16 shortnose sturgeon when both facilities are operational, we expect an average of 4.5 shortnose sturgeon to be impinged annually when just IP3 is operational. Over the two year period we expect the impingement of nine shortnose sturgeon.

In addition to the withdrawal of water from the IP2 and IP3 intakes for cooling water and service water, additional service water for IP2 will be withdrawn from the IP1 intakes. This intake is located between the IP2 and IP3 intakes, also along the eastern shore of the Hudson River. NRC was not able to provide us with any monitoring data from IP1, and it is unclear if any monitoring at IP1 has ever occurred. Given the lack of intake specific monitoring data, we have assessed the likelihood of impingement of shortnose sturgeon at the IP1 intakes as compared to the likelihood of impingement at the IP2 and IP3 intakes. As noted above, there is no geographic difference in intake location which would make impingement at IP1 more or less likely at IP2 or IP3. The intake velocity, trash bar spacing and screen mesh size are also comparable between IP1 and IP2 and IP3. The major difference between the IP1 intake and the IP2 and IP3 intakes is the volume of water removed. Together, IP2 and IP3 remove a maximum flow of approximately 1.746 million gallons per minute. According to information provided by Entergy[12], the IP1 intake structure has two redundant forebays, each with a maximum or design flow of 10,000 gpm; however, as currently configured in a redundant manner, the maximum flow of the intake is 10,000 gpm. Entergy further indicates that the typical peak operating flow for IP1 is 5,500 gpm with 6,000 gpm as the limit of the IP2 load.

Given the maximum 6,000 gpm operation of the IP1 intake, this represents approximately 0.34% of the total intake flow from IP2 and IP3 (6,000gpm/1,746,000gpm). Assuming, that all other parameters being equal, the potential for impingement is related to the volume of water withdrawn, we expect that the number of shortnose sturgeon impinged at the IP1 intakes would be 0.34% of the number of shortnose sturgeon impinged at IP2 and IP3. As explained above, adjusting the long term average by 400%, we expect 16 shortnose sturgeon to be impinged at IP2 and IP3 annually. Assuming that an additional 0.34% would be impinged at the IP1 intake, we would expect an average of 0.05 shortnose sturgeon to be impinged annually at IP1 intakes. Between now and 2033 when the IP2 license expires (a period of 21 years), we would expect one shortnose sturgeon to be impinged at IP1.

[12] Email from Elise Zoli, representing Entergy, to NMFS and NRC on September 21, 2011.

In summary, using the average annual impingement from 1974-1990 and adjusting it by 400% to account for increases in the shortnose sturgeon population and then adding 0.34% to account for the IP1 intakes, we would expect a total impingement at the intake screens of 337 shortnose sturgeon between now and September 2033 (the time period when IP2 and IP3 will be operational and water will be withdrawn through the IP1 intakes) and an additional 9 shortnose sturgeon from September 28, 2033-December 12, 2035 when just IP3 will be operational. This results in a total estimate of 346 shortnose sturgeon impinged at Indian Point intake screens.

Calculations based on Entergy's Impingement Density Calculations
Entergy states that some of the interannual variability in impingement is likely due to the variable operation of the facility (i.e., changes in the volume of water withdrawn due to outages). To account for this variable, Entergy developed the impingement density estimate which calculates the average number of sturgeon impinged per month per volume of water removed. Entergy has determined that operations of IP2 and IP3 from 2001-2008 are representative of future operations, including under the terms of the proposed new licenses. Entergy has indicated that there are no power uprates or other changes being proposed at the facility that would result in more water being withdrawn in the future. Therefore, Entergy applied an adjusted impingement density (to account for increases in the shortnose sturgeon population) to the predicted volume of water to be removed in the future (based on 2001-2008 operation), to predict future impingement of shortnose sturgeon.

Entergy predicted future impingement using the impingement density values. They consider the annual average water withdrawal rate for 2001-2008 to be representative of future operations of the Indian Point cooling water intake structures. Because operations vary monthly, with average water withdrawal lower in some months than others, they factored this variability in operations into the calculations. To account for the increase in shortnose sturgeon in the Hudson River, Entergy adjusted the monthly impingement density rates by 400%. They then applied this impingement density rate to the predicted water withdrawal for the future operating period. Using this method, they predict that impingement would vary monthly, with no impingement in June, July and December and a peak in April; in total, this method estimates the impingement of 20 shortnose sturgeon per year (see Figure 4 below).

Figure 4. Among-month pattern of projected average shortnose sturgeon impingement at IP2 and IP3, and average of IP2 and IP3 flows (cooling water plus service water) for the years 2001-2008. From Entergy 2012.

Comparison of results of the two calculation methods

Both of the methods considered above make adjustments to account for the greater number of shortnose sturgeon in the Hudson River now as compared to the number when impingement monitoring occurred. The Entergy method predicts greater numbers of future impingement than just using the average annual impingement rate from 1974-1990. Entergy predicts that future operations will be similar to operations from 2001-2008. During that time, average service and cooling water flows through the IP2 and IP3 intakes ranged from 1 million to 1.8 million gallons per minute depending on the month. From 1976-1990, average service and cooling water flows through the IP2 and IP3 intakes ranged from 0.6-1.2 million gallons per minute depending on the month suggesting an overall increase of 1.5-1.6 times the amount of water to be withdrawn in the future as compared to 1976-1990. If we assume that the risk of impingement increases with the volume of water removed through the intakes, then it becomes important to factor in increased water usage when considering future impingement. If we adjust the calculated impingement number (16; based on the annual average) by a factor of 1.6 to account for increased water usage we would estimate an annual average of 25.6 shortnose sturgeon impinged at IP2 and IP3.

Because of the uncertainty related to the factors associated with impingement rates, it is difficult to determine which estimate is a better predictor of future impingement. The Entergy methodology assumes there will be no impingement of shortnose sturgeon in June, July or

December. However, a review of the impingement data that are available suggests that this may not be a reasonable assumption. For example, two of the 32 impinged shortnose sturgeon were impinged in June (1974 and 1975), which suggests that impingement is likely to occur in June. Because of this, and because we believe that by making adjustments to our estimate to account for increased water usage we are removing the potential for underestimating due to lower water usage in the past, we have determined that the best estimate of future impingement at IP2 and IP3 is an average of 19 shortnose sturgeon per year at IP2 and 7 at IP3 . This estimate is based on the annual average estimate of 4 sturgeon per year during the period of 1974-1990 (exclusive of 1975 when only IP3 was operational) and adjustments made to account for a 400% increase in the number of shortnose sturgeon in the Hudson River now as compared to the time when impingement sampling occurred and a 160% increase to account for increases in the predicted amount of water to be withdrawn in the future as compared to 1976-1990. Using the calculation discussed previously for IP1, we expect the annual average impingement of 0.09 shortnose sturgeon at the IP1 intakes.

Between now and September 23, 2033 when the proposed renewed operating license for IP2 will expire, we expect up to 395 shortnose sturgeon will be impinged at the IP2 intakes (Ristroph screens), inclusive of 2 shortnose sturgeon impinged at the IP1 intakes used for IP2 service water. Between now and December 12, 2035 when the proposed renewed operating license for IP3 will expire, we expect up to 167 shortnose sturgeon will be impinged at the IP3 intakes (Ristroph screens). In total, if both facilities operate until the expiration dates of the proposed renewed licenses, up to 562 shortnose sturgeon will be impinged as a result of Indian Point operations. We expect the amount of impingement to vary annually; however, the conclusions reached in the Opinion are based on it taking 21 years to reach the total impingement level for IP2 (inclusive of IP1 intakes) and 23 years to reach the total impingement level for IP3.

Consistent with the period when monitoring was ongoing, we expect the number of impingements to be variable year to year. Adjusting the annual impingement values from 1974-1990 using the methodology outlined above to account for differences in population size and increased water withdrawal (i.e., multiplying the estimated impingement value by 4 and then by 1.6), we expect that annual impingement values will range from zero to 83 shortnose sturgeon per year at IP2 and IP3, collectively (range of 0-71 at IP2 and 0-32 at IP3). However, over time, we expect the average to be 19 shortnose sturgeon impinged per year at the IP2 Ristroph screens and 8 at the IP3 Ristroph screens. We also anticipate that there will be no more than two consecutive years where there are more than 25 impingements at IP2 and no more than two consecutive years where there are more than 13 impingements at IP3. For example, we do not anticipate that there would ever be more than 71 shortnose sturgeon impinged at IP2 in any given year or 26 shortnose sturgeon impinged at IP2 in any three consecutive years. Similarly, for IP3 we do not anticipate the impingement of more than 32 shortnose sturgeon in any given year or 14 (or more) shortnose sturgeon impinged at IP3 in any three consecutive years.

Our calculations are illustrated below:

a. Average annual impingement 1974-1990 (excluding 1975): 4
b. Multiply 4 by 400% to account for increase in shortnose sturgeon population = 16

c. Account for increased water usage by multiplying 16 by 160% = 25.6 rounded up to 26
d. During 1974-1990, 28% of reported impingement of shortnose sturgeon occurred at IP2. Annually we then expect 28% of 26 to occur at IP3; = 19 at IP2 and 7 at IP3
e. IP1 withdraws 0.34% of the water withdrawn by IP2 and IP3. Expect 0.34% of total impingement at IP1. (0.0034 x 26) = .088 annually; water will be withdrawn through the IP1 intakes for 21 years. 0.088 x 21 = 1.85, rounded up to 2
f. Based on license dates, we expect IP2 to operate from now until September 28, 2033, a total of 21 years. Adjusting the annual average impingement for IP2 and IP3 by 72% to account for the percentage of the impingement we expect at IP2 times 21 years (26*.72*21) = 393 shortnose sturgeon plus two at IP1 = 395, at an average rate of 19 shortnose sturgeon per year.
g. Based on license dates, we expect IP3 to operate from now until December 12, 2035, a total of 23 years. Adjusting the annual average impingement for IP2 and IP3 by 28% to account for the percentage of the impingement we expect at IP3 times 23 years (26*.28*23) = 167 shortnose sturgeon, at an average rate of 7 per year.
h. In total, we expect the impingement of 562 shortnose sturgeon to be impinged at the IP1, IP2 and IP3 intakes.

Comparison of estimate of impingement of shortnose sturgeon in NMFS 2011 Opinion and this Opinion

In the 2011 Opinion, we estimated that over the 20 year extended operating period, 168 shortnose sturgeon would be impinged at IP1, IP2 and IP3, collectively. We calculated this estimate by first determining the average annual impingement rate at IP2 from 1974-1990 and the average annual impingement rate at IP3 from 1976-1990, which we stated was 1.3 and 0.73, respectively. To account for the 400% increase in the shortnose sturgeon population between the late 1970s and the late 1990s, we adjusted those annual impingement rates by a factor of 4 was 5.2 and 2.9 shortnose sturgeon per year, respectively. We then multiplied those annual estimates by the number of years each unit would be operational (20) to get a total estimate for IP2 of 104 and a total estimate for IP3 of 58. We then used the calculations noted above (6,000gpm/1,746,000gpm) to estimate the amount of impingement at IP1. We estimated the impingement of six additional shortnose sturgeon at IP1. However, it appears that we made a mathematical error (multiplying 162 by 0.034 instead of 0.0034) and that number should have been one, not six.

In reviewing the methodology used in 2011, we now recognize three ways that this resulted in an underestimate of future impingement. First, we relied on the actual observed number of impingements of shortnose sturgeon, not the estimated number of impingements based on collection efficiency. Collection efficiency takes into account the fraction of fish that enter the intake structure but do not make it into impingement collections. According to NRC, currents may sweep some fish around the traveling screens because screens do not form a perfectly water tight seal against the intake structure. NRC has stated that the CE adjusted estimates should be more accurate. We also have new information on the volume of water Entergy is likely to withdraw through the IP2 and IP3 intakes in the future (Entergy 2012). The information provided by Entergy indicates that water withdrawal will range from 1.2-1.6 mgd depending on the month. They report water usage from 1974-1990 as ranging from 0.6-1.2 mgd depending on the month. We expect a relationship between water usage and impingement; the more water that is withdrawn the higher the risk for impingement. Therefore, by not adjusting the historic impingement numbers to account for current and future increases in water use, our 2011 estimate likely underestimates future impingement of shortnose sturgeon. Additionally, in the 2011 Opinion we did not consider additional shortnose sturgeon that we expect will be be impinged at the trash racks. While we are still not able to estimate the number of shortnose sturgeon that will be impinged at the trash racks, we recognize that this is an additional source of impingement. We believe the methodology described above, which avoids the underestimation of impingement at the intake screens, and results in a total estimate of 562 shortnose sturgeon impinged at Indian Point intake screens is a better approach.

Predicted Mortality of Impinged Shortnose Sturgeon
NRC has stated that the installation of the modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement mortality for shortnose sturgeon. However, because no monitoring occurred after the installation of the modified Ristroph screens, more recent data are not available and, it is not possible to determine to what extent the modified Ristroph screens may have reduced impingement mortality for sturgeon as compared to pre-1991 levels.

Of the 32 shortnose sturgeon collected during impingement sampling at IP2 and IP3, condition (alive or dead) is reported for nine fish (NRC BA 2010); of these, seven are reported as dead (78% mortality rate). There is no information to indicate whether alive meant alive and not injured, or alive and injured. There is also no additional information to assess whether these fish reported as dead were likely killed prior to impingement and drifted into the intake or whether being in the intake bays and/or impingement was the sole cause of death or a contributing cause of death.

Before installation of modified Ristroph screen systems in 1991, impingement mortality at IP2 and IP3 was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design of the screens, as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at IP2 and IP3. The Fletcher study reported mortality following an 8-hour holding period in an attempt to account for delayed mortality that may result from injuries suffered during impingement. As reported in Fletcher (1990), this monitoring occurred between September 16 and October 24, 1986 at one intake bay at IP2. Mortality rates are reported for a variety of species: bay anchovy, American shad, bluegill, pumpkinseed, American eel, hogchoker, banded killifish, blueback herring, striped bass, Atlantic tomcod, white perch and weakfish. The size of individual fish or the range of sizes per species are not provided. During release-recapture studies at IP2 carried out from September 4-13, 1986, striped bass and white perch were tested, with sizes ranging from 5.0-15.2cm FL. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad, with mortality rates ranging from 9-62%, depending on species. No evaluation of survival of shortnose sturgeon on the modified Ristroph screens at IP2 or IP3 was made and no monitoring has occurred since the screens were installed in 1991. No shortnose sturgeon were observed during the limited monitoring that occurred at the modified Ristroph screens. While mortality rates for all species observed were lower as compared to the previous screen design, because the monitoring occurred over such a limited period of time and in only one intake bay and at a different time of year than the 1985 studies, we have concerns about whether the 1986 monitoring results are representative of impingement mortality year round at all intake bays. There are several reasons why we are unable to rely on any reported increase in survival for the modified screens or use the survival rates for other species to predict survival of sturgeon. This is because (1) none of these tests used sturgeon; (2) the species considered in the monitoring and testing are not morphologically similar to sturgeon and are considerably smaller than the larger sturgeon that could pass through the trash bars and be impinged at the Ristroph screens, and (3) there are no studies comparing impingement mortality or likelihood of injury of sturgeon compared to other species at any intake screens that could be used to estimate mortality rates for sturgeon based on the rates for other species. PSEG prepared estimates of impingement survival following interactions with Ristroph screens at their Salem Nuclear Generating Station located on the Delaware River (PSEG in Seabey and Henderson 2007); survival of shortnose sturgeon was estimated at 60% following impingement on a conventional screen and 80% following survival at a Ristroph Screen; survival for other species ranged from 0-100%. It is important to note that PSEG did not conduct field verifications with shortnose sturgeon to demonstrate whether these survival estimates are observed in the field. A review by NMFS of shortnose sturgeon impingement information at Salem indicates that all recorded impingements (20 total since 1978; NRC 2010) have been at the trash racks, not on the Ristroph screens. This is consistent with the expectation that all shortnose sturgeon in the vicinity of the Salem intakes would be too large to fit through the trash bars and potentially contact the Ristroph screens. Thus, while there is impingement data from Salem, there is no information on post-impingement survival for shortnose sturgeon impinged on the Ristroph screens. The majority of impinged shortnose sturgeon at Salem have been dead at the time of removal from the trash racks (17 out of 20; 85%),

In his 1979 testimony, Dadswell discussed a mortality rate of shortnose sturgeon at traditional screens of approximately 60%, although it is unclear what information this number is derived from as no references were provided and no explanation was given in the testimony. NRC states in their BA that this was based on the percent of shortnose sturgeon alive vs. dead during one year of impingement monitoring that was available at the time.

No further monitoring of the IP2 or IP3 intakes or impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991, and any actual reduction in mortality or injury to shortnose sturgeon resulting from impingement after installation of these systems at IP2 and IP3 has not been established. As explained above, shortnose sturgeon with a body width of at least three inches would not be able to pass through the trash bars and would become impinged on the trash bars and not pass through to the Ristroph screens. Survival for shortnose sturgeon impinged on the trash bars would be dependent on the length of time the fish was impinged and whether it also interacted with debris that collects on the bars. The available data for shortnose sturgeon impingement at trash bars indicates that mortality is likely to be high (e.g., 85% at Salem nuclear facility) even when a monitoring program is in place designed to observe and remove impinged fish[13].

[13] At Salem, trash racks in front of the intakes are cleaned at least three times per week and the trash bars are

As noted above, with particular assumptions, healthy shortnose sturgeon (yearlings and older) are expected to be able to readily avoid an intake with an approach velocity of 1.0 fps or less. As noted above, we expect that all shortnose sturgeon impinged at the trash racks will be dead or stressed, yet the cause of death/stressor is currently unknown.

Some of the shortnose sturgeon impinged at the Ristroph screens are likely to be dead or suffering from injury or illness. Some sturgeon caught in the buckets of the Ristroph screen are likely to be healthy and free swimming; some of those fish are likely to experience injury or mortality while being transported to the sluice. Other sturgeon that become impinged on the traveling screens are likely to suffer injury or mortality due to their impingement. We also expect that some sturgeon will become injured or die from being in the intake embayment between the trash bars and screens; we expect that these fish will become impinged on the Ristroph screens due to the flow of water and operation of the bucket system. Past monitoring at IP2 and IP3 indicates that mortality rates are approximately 78% (assuming the best case, that all shortnose sturgeon recorded as "alive" were not just alive but were uninjured), monitoring at the Salem nuclear facility indicates that mortality rates at the trash bars are approximately 85%. With no monitoring or inspection plan in place to detect and remove shortnose sturgeon that become impinged on the trash bars, mortality rates for shortnose sturgeon impinged on the trash bars are more likely to be as high as 100%, as there would be no opportunity for fish to be removed once stuck between or on the bars.

Based on the available information, it is difficult to predict the likely mortality rate for shortnose sturgeon following impingement on the Ristroph screens. Shortnose sturgeon passing through the trash bars and becoming impinged on the Ristroph screens are likely to be small juveniles with body widths less than three inches. Based on the 8-hour survival rates reported by Fletcher for other species, it is likely that some percentage of shortnose sturgeon impinged on the Ristroph screens will survive. Some shortnose sturgeon that become impinged on the Ristroph screens are likely to be suffering from injuries, illnesses, or other stressors that have impaired their swimming ability and prevented them from being able to escape from the relatively low approach velocity (reported to be 1.0 fps or less as measured within the intake bay in front of the Ristroph screens, which yearling and older shortnose sturgeon are expected to be able to avoid (Kynard et al. 2005)). However, because we do not know the condition of the fish prior to impingement, and we have no site-specific studies to base an estimate or even species-specific studies at different facilities, we will assume the worst case, that mortality is 100%.

Using the impingement rates calculated above, and the worst case mortality rate of 100% at the modified Ristroph screens, 2 shortnose sturgeon are likely to die as a result of impingement at the IP1 screens, 393 at the IP2 Ristroph screens and 167 at the IP3 Ristroph screens. Therefore, we expect a total of 562 shortnose sturgeon to die as a result of impingement at IP2 (including IP1) and IP3 Ristroph screens between now and the time that the extended operating licenses expire. For the reasons given above, we believe that the 100% mortality estimate is a conservative, yet reasonable, mortality rate for impinged shortnose sturgeon at the Ristroph screens. We can not predict the number of shortnose sturgeon likely to be impinged at the IP

---

inspected every four hours from April through October.

trash racks. However, based on the available information, we expect all of these shortnose sturgeon to be dead or stressed, with the cause of death/stressor currently unknown.

7.1.2.2 Impingement of Atlantic sturgeon at IP2 and IP3

Daily monitoring for sturgeon occurred at the IP2 and IP3 Ristroph screens from 1974-1990. The actual observed number of impingements is recorded as "Observed Fish" below (called the "Level 5 Count" in NRC 2010 and 2012). This number was adjusted to account for collection efficiency to determine the "Estimated Fish" below (the "CE Adjusted Level 5 Count" in NRC 2010 and 2012). No monitoring of impingement of Atlantic sturgeon or any other species has occurred at the trash bars.

A total of 601 Atlantic sturgeon were observed during impingement monitoring at IP2 and IP3 from 1974-1990. Adjusting for collection efficiency, it is estimated that a total of 1,334 Atlantic sturgeon were impinged at IP2 and IP3 during this period. For this period, the average number of Atlantic sturgeon impinged per year at IP2 and IP3 was 78.5 Atlantic sturgeon/year (see Table 3 below).

	IP2		***IP3***		
Year	**Observed Fish**	**Estimated Fish**	**Observed Fish**	**Estimated Fish**	**Total IP2 and IP3 Annual Estimate**
1974	101	282	10	17	299
1975	118	302	NR	NR	302
1976	8	17	8	14	31
1977	44	105	153	252	357
1978	16	38	21	31	69
1979	32	75	38	51	126
1980	9	24	10	17	41
1981	3	8	5	7	15
1982	1	2	1	1	3
1983	3	6	0	0	6
1984	3	6	5	10	16
1985	9	19	17	25	44
1986	2	6	5	6	12
1987	2	6	1	2	8
1988	1	2	0	0	2
1989	0	0	0	0	0
1990	0	0	2	3	3
Total	352	**898**	276	**436**	**1334**

To account for interannual variations in operations, Entergy calculated an “impingement density” of sturgeon (see above). For Atlantic sturgeon, on average, the highest impingement occurred in April (approximately 15 per month), with the lowest impingement (less than two per month) occurring in late Fall.

The impingement density values calculated by Entergy are shown for each year 1976 through 1990[14] for Atlantic sturgeon in Figure 5. This figure presents year on the horizontal axis and the vertical axis shows the annual sturgeon impingement density (sturgeon per million gpm) for IP2 and IP3 combined. The annual sturgeon impingement density shown on the vertical axis of Figure 5 is calculated as the annual number (count) of sturgeon impinged and then scaled upward by monthly collection efficiency values for each Unit in each year and divided by the annual average cooling water withdrawal rate for that Unit and year in million gallons per minute. The impingement density values plotted on the vertical axis in Figure 6 represents the sum of each density value for IP2 and IP3 for each year.

Annual Atlantic sturgeon impingement density (average of monthly estimates of impingement density based on number impinged and the average monthly flow rate) ranged from 0 (1989) to 54 (1977).

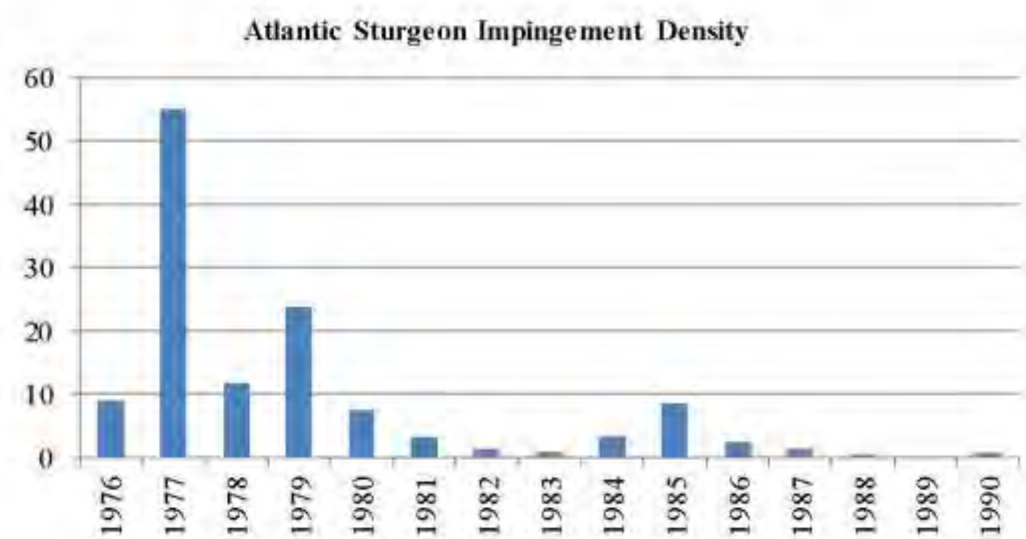


Figure 5. Among year pattern of Atlantic sturgeon impingement density at IP2 and IP3 (combined). Annual density is the average of monthly estimates of impingement density based on number impinged and the average monthly flow rate (million gpm). From Entergy 2012.

14 Entergy used the years 1976-1990 for this method because those were the years that flow data was available. Also, IP3 was not operational in 1975.

Figure 6. Among-month pattern of average Atlantic sturgeon impingement at IP2 and IP3, and average flows (cooling water plus service water) for the years 1976-1990.

Predicted Future Impingement of Atlantic sturgeon at IP Trash Racks
If through-rack velocity at the trash racks in front of IP1, IP2 and IP3 is 1.0 fps, as reported by Entergy, and assuming conditions similar to those in laboratory studies, we would not anticipate any impingement of Atlantic sturgeon at the trash racks. That is because sturgeon that are big enough to not be able to pass through the racks (i.e., those that have body widths greater than three inches) would be adults or large subadults. These fish are able to avoid impingement at velocities of up to 3 feet per second and should be able to readily avoid getting stuck on the trash racks. We know sturgeon (whether dead or alive) are present at the trash bars given that the smaller individuals have to pass through them to get to the screens, and both smaller and larger individuals use this part of the Hudson. Therefore, we expect the larger individuals that are too large to pass through the bars, yet unable to swim away from them, will be impinged on them. The only impingement at the trash racks that we anticipate is adult or subadult Atlantic sturgeon that are dead or stressed and therefore unable to swim away from the trash racks. While we expect Atlantic sturgeon will be impinged at the trash racks, the cause of death/stressor is currently unknown. As noted above, there has been no past monitoring of impingement of any species, including Atlantic sturgeon, at the trash racks. Therefore, there is no information from which to predict a future impingement estimate. We considered estimating impingement based on impingement of shortnose sturgeon at other power plants, however there are no comparable facilities. Therefore, while we expect that dead or stressed Atlantic sturgeon will be impinged at

IP1, IP2 or IP3 during the continued operation of IP2 and IP3, we are unable to estimate the total number of these sturgeon on an annual average.

Predicted Future Impingement of Atlantic Sturgeon at IP2 (including IP1) and IP3 Intake Screens

We examined the available data on Atlantic sturgeon impinged at IP2 and IP3 to determine the length of impinged fish. Of the 601 Atlantic sturgeon recorded at IP2 and IP3 from 1974-1990, length is available for 36 individuals. These fish ranged in size from 14-79 cm. Like shortnose sturgeon, this is consistent with our estimates of the size of fish that would be able to pass through the trash bars but is larger than the size of fish we would expect to be vulnerable to impingement.

We examined condition information to determine if there was an indication that these fish were sick or injured. We expect fish that are sick or injured to have reduced swimming speed or endurance and that they may not be able to avoid impingement the way a healthy fish would. Unfortunately, the data that is available on the 601 impinged Atlantic sturgeon only indicates condition (alive or dead) for 37 individuals (the same ones that had length recorded plus one additional). Of these 37 fish, 22 were dead; however, there does not appear to be a relationship between the length of the fish and whether they were alive or dead.

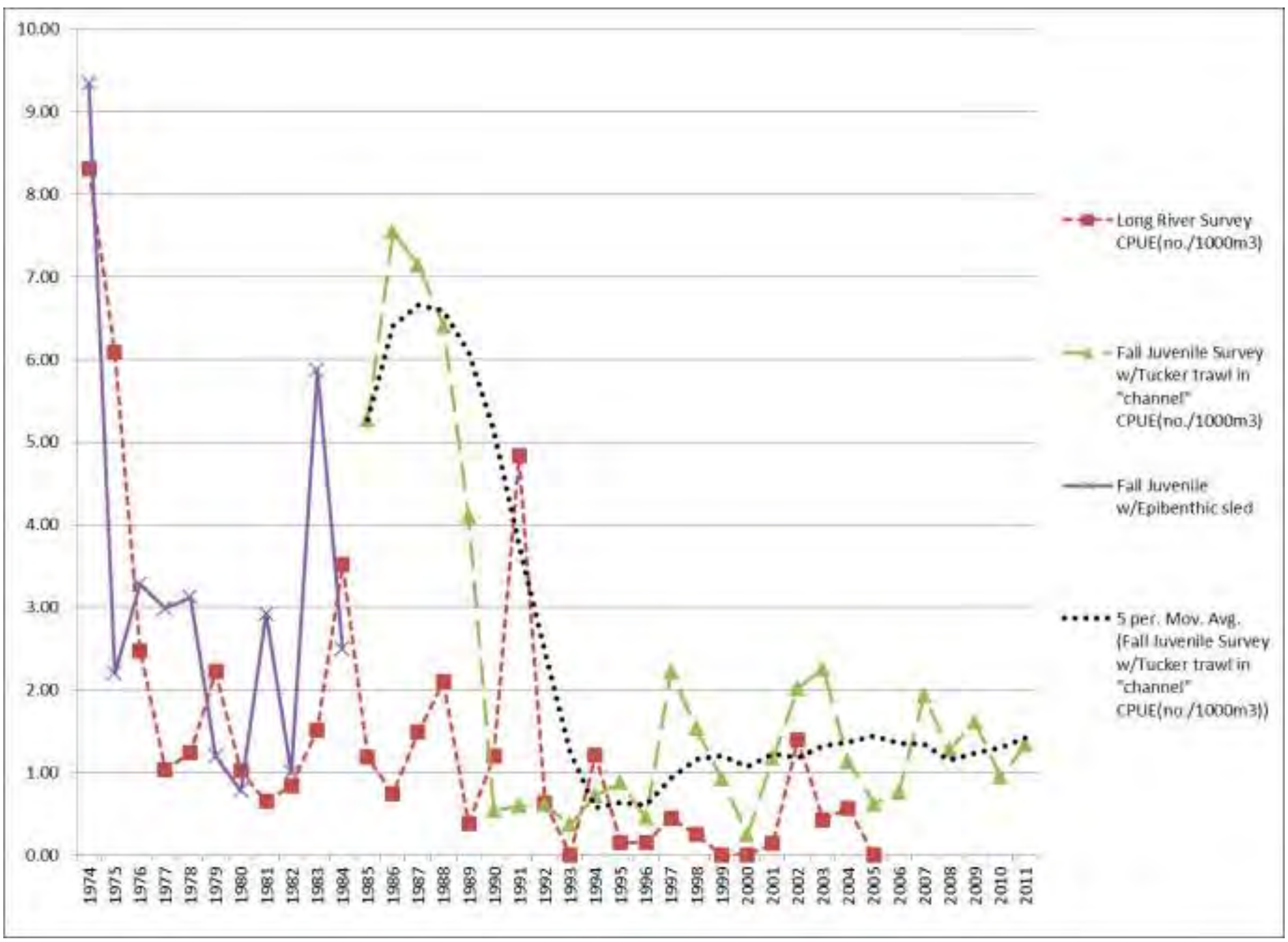
Like shortnose, based on the size of the Atlantic sturgeon that have been impinged at IP2 and IP3 and the analysis completed by Entergy, it appears that there are other factors than the size of the fish that are contributing to the likelihood of impingement. We expect that the factors discussed above for shortnose (i.e,. “active” capture of fish by the buckets on the Ristroph screens, possible impairment due to illness or injury, disorientation or exhaustion due to being “trapped” between the trash racks and Ristroph screens, conditions in the area including water temperature), also contribute to the impingement of Atlantic sturgeon and would explain why fish that are of sufficient size to avoid impingement at the reported velocities would still be impinged.

The impingement of sturgeon at IP2 and IP3 is probably due to a combination of the factors mentioned above, all of which explain how impingement can occur despite reported intake velocities at levels that are below those that most sturgeon should be able to readily escape from. Despite the low intake velocity reported by Entergy, impingement of Atlantic sturgeon occurred in the past and is expected to continue to occur. The lack of recent monitoring data makes predictions of future impingement more difficult. Estimating future impingement is made more difficult by the variability in annual impingement rates and not knowing the degree to which factors discussed above contribute to these differences. Like we did for shortnose sturgeon, we have considered several ways to estimate likely future impingement of Atlantic sturgeon including: (1) using the annual average number of impingements to predict future impingement; and (2) using Entergy’s impingement density calculations.

Calculations based on Impingement data from 1974-1990

During the period that impingement sampling occurred, the number of Atlantic sturgeon impinged ranged from zero to 357. The average annual impingement was 78.4 Atlantic sturgeon/year. Excluding 1975, when only IP2 was operational, the average was 60.8 per year. As noted in the Status of the Species section of this Opinion, the Atlantic sturgeon population in the Hudson River has had a decreasing trend over the time period that impingement monitoring occurred. Therefore, we considered if the average impingement rate during 1974-1990 would overestimate future impingement.

We have made the basic assumption that the risk of impingement increases with the size of the population. That is, we expect that if there are more fish in the river there is more opportunity for individuals to be impinged. We expect if there are more sturgeon in the action area then the impingement rate would be higher. As evidenced by estimates of juvenile abundance, the Atlantic sturgeon population in the Hudson River has declined over time. Peterson et al. (2000) found that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. Similarly, longterm indices of juvenile abundance (the Hudson River Long River and Fall Shoals surveys) demonstrate a longterm declining trend in juvenile abundance. The figure below (Figure 7) illustrates the CPUE of Atlantic sturgeon in the two longterm surveys of the Hudson River. Please note that the Fall Shoals survey switched gear types in 1985. We do not have the CPUE data for the Long River Survey for 2006-2011.



As evidenced in the above table, impingement of Atlantic sturgeon declined over time. The annual average impingement from 1974-1978 was 211.6 Atlantic sturgeon; from 1986-1990 it was 5. Unlike for shortnose sturgeon where the impingement trend did not seem to match the trend of the population, the decline in Atlantic sturgeon in the river appears to be reflected in the declining trend in impingements of Atlantic sturgeon over time. This could be due to the time period of impingement monitoring better reflecting the time when changes were experienced in the Atlantic sturgeon population than changes in the shortnose sturgeon population.

CPUE for the Fall Juvenile Survey for the most recent five year period (2007-2011) is approximately 27% of the CPUE from 1985-1990 (1.41 compared to 5.17). The CPUE results suggest a sharp decline in juvenile Atlantic sturgeon in the Hudson River after 1989. While the CPUE results only indicate trends for juvenile Atlantic sturgeon, given the size of the Atlantic sturgeon impinged at Indian Point, they are a good representative of the year classes affected by operations of Indian Point. Therefore, while we do not have an index of the Hudson River population as a whole, that type of index may not be relevant for considering the number of Atlantic sturgeon available for impingement at Indian Point. Because of the change in gear type, we cannot directly compare CPUE from 1974-1990 (when impingement monitoring occurred) to CPUEs for more recent time periods. The only CPUEs that overlap with the impingement monitoring that can be directly compared to current CPUEs are those from 1985-1990. However, as evidenced in the figure above, there was an overall declining trend in the number of juvenile Atlantic sturgeon in the Hudson River since the mid-1970s. This declining trend is reflected in declines in impingement at Indian Point. CPUE data from 2007-2011 is more than two times higher than the CPUE from 1991-1996 which may be suggestive of an increasing trend in juvenile abundance. However, the index suggests that numbers of juveniles are still significantly lower now than during the end of the impingement monitoring period. Given the high variability between years, it is difficult to use this data to assess short term trends, however, when looking at a five-year moving average, the index appears to be increasing from lows in the early 1990s, but is still much lower than the 1970s and 1980s.

Based on the CPUE, there appear to be approximately 27% of the number of Atlantic sturgeon juveniles in the Hudson River now as compared to the period 1985-1990. During that period, the average annual impingement rate was 11.5 Atlantic sturgeon per year. Using the CPUE to adjust that rate to predict current abundance (i.e., 27% of 11.5), we would expect an annual average impingement rate of 3.1 Atlantic sturgeon per year. As noted above, there are some indications that the trend in juvenile abundance is increasing. The period 1985-1990 captures the period just prior to the sharp decline in Atlantic sturgeon juvenile abundance. Because there is some evidence of an increasing trend in juveniles in the Hudson River, it is possible that by reducing the average impingement rate from 1985-1990 we could underestimate future impingement.

Entergy conducted an analysis to determine if there was a statistically significant correlation between reported Atlantic sturgeon population size and impingement density. We would expect that the more sturgeon there were in the river, the higher the impingement density would be because there would be more sturgeon that had the potential to be impinged. However, the analysis does not reveal a statistically significant correlation (Entergy 2012). It is likely that this lack of statistical correlation is not due to the fact that there is no relationship between population size and impingement but because impingement of sturgeon is a rare event and because of the high interannual variability in impingement numbers which makes detection of a statistically significant correlation difficult.

We considered reviewing impingement data for other Hudson River power plants to determine if this predicted correlation between decreases in individuals and increased impingement of individuals would be observed. Long term sturgeon impingement monitoring is only available for the Roseton and Danskammer facilities. However, since 2000, both facilities have operated at reduced rates and there has been minimal sturgeon impingement; in every year it has been no more than one. As the Roseton and Danskammer facilities are not currently operating in the same capacity they were in the past, it is not possible to make an accurate comparison of past and present impingement which could serve to determine if it was reasonable to assume that an increase in impingement would occur in association with any change in the number of Atlantic sturgeon in the Hudson River. As noted above, the Lovett facility has been closed. The Bowline facility has always operated with extremely low levels of impingement, thought to be primarily due to the location of the intakes in a nearly enclosed embayment of the River where Atlantic sturgeon are thought to be unlikely to occur (Bowline Pond) (NMFS 2000). Therefore, we are not able to use information from other power intakes to determine if there is an association between changes in population size and rates of impingement.

We also considered examining relationships between population trend and impingement rates at facilities outside the Hudson River. Monitoring of shortnose sturgeon impingement at the Salem Nuclear Generating Station, on the Delaware River, has been ongoing since 1978. However, reporting of impinged Atlantic sturgeon only began in 2010, with one impingement recorded to date. Because of the lack of data, it is not possible to use this information to determine if changes in population size are related to changes in impingement rates.

Despite the uncertainty in determining the factors that are related to impingement, the assumption that the more sturgeon there are in the river the higher the potential for impingement, is reasonable. Because we expect fewer Atlantic sturgeon in the river now than during the period of impingement monitoring we considered adjusting the annual impingement value by 73% (the decrease in juveniles suggested by the CPUE from the Fall Shoals Survey). However, by doing this we may be underestimating future impingement if Atlantic sturgeon juvenile abundance is increasing in the way the Fall Shoals Survey CPUE suggests (i.e., an increase from the early 1990s, but still depressed from the 1970s). Based on what we know about Atlantic sturgeon in the river, the impingement rates from 1985-1990 appear to be the most reflective of future impingement rates. Using the annual average of Atlantic sturgeon impinged during this period, we would anticipate the impingement of an average of 11.5 Atlantic sturgeon per year at IP2 and IP3 (combined) during the period that these facilities will continue to operate. From September 28, 2033 – December 12, 2035, only IP3 will be operational. During the period 1974-1990, approximately 33% of the impinged Atlantic sturgeon were at IP3. Using that ratio and applying it to the estimate of 11.5 Atlantic sturgeon when both facilities are operational, we expect an average of 3.8 Atlantic sturgeon to be impinged annually when just IP3 is operational. Over the two year period we expect the impingement of 8 Atlantic sturgeon.

As described above for shortnose sturgeon, we also need to account for impingement of Atlantic sturgeon at IP1. Using the methodology discussed above, we assume that an additional 0.34%

would be impinged at the IP1 intake; therefore, we would expect an average of 0.04 Atlantic sturgeon to be impinged annually at IP1 intakes. Between now and 2033 when the IP2 license expires (a period of 21 years), we would expect one Atlantic sturgeon to be impinged at IP1.

In summary, using the average annual impingement from 1985-1990 and then adding 0.34% to account for the IP1 intakes, we would expect a total impingement of 243 Atlantic sturgeon between now and September 2033 (the time period when IP2 and IP3 will be operational and water will be withdrawn through the IP1 intakes) and an additional 8 Atlantic sturgeon from September 28, 2033-December 12, 2035 when just IP3 will be operational. This results in a total estimate of 251 Atlantic sturgeon impinged at Indian Point screens from now until December 12, 2035.

Calculations based on Entergy's Impingement Density Calculations
Entergy applied an adjusted impingement density (to account for decreases in the Atlantic sturgeon population) to the predicted volume of water to be removed in the future (based on 2001-2008 operation), to predict future impingement of Atlantic sturgeon.

Entergy predicted future impingement using the impingement density values. They consider the annual average water withdrawal rate for 2001-2008 to be representative of future operations of the Indian Point cooling water intake structures. Because operations vary monthly, with average water withdrawal lower in some months than others, they factored this variability in operations into the calculations. To account for the decrease in Atlantic sturgeon in the Hudson River, Entergy adjusted the monthly impingement density rates by reducing them 80%. This was based on Peterson et al. (2000) finding that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. They then applied this impingement density rate to the predicted water withdrawal for the future operating period. Using these rates to estimate future impingement, Entergy predicted an annual average impingement rate of 11.45 individuals per year.

Figure 8. Among-month pattern of projected average Atlantic sturgeon impingement at IP2 and IP3, and average of IP2 and 3 flows (cooling water plus service water) for the years 2001-2008. From Entergy 2012.

Comparison of results of the two calculation methods

Both of the methods considered above make adjustments to account for the lesser number of Atlantic sturgeon in the Hudson River now as compared to the number when impingement monitoring occurred. The Entergy method predicts an annual average impingement rate of 11.4 Atlantic sturgeon per year. Our method, using the average impingement rate from 1985-1990, predicts an annual average rate of 11.5 Atlantic sturgeon per year. Entergy predicts that future operations will be similar to operations from 2001-2008. During that time, average service and cooling water flows through the IP2 and IP3 intakes ranged from 1 million to 1.8 million gallons per minute depending on the month. From 1976-1990, average service and cooling water flows through the IP2 and IP3 intakes ranged from 0.6-1.2 million gallons per minute depending on the month suggesting an overall increase of 1.5-1.6 times the amount of water to be withdrawn in the future as compared to 1976-1990. If we assume that the risk of impingement increases with the volume of water removed through the intakes, then it becomes important to factor in increased water usage when considering future impingement. If we adjust the calculated impingement number (6; based on the annual average from 1985-1990) by a factor of 1.6 to account for increased water usage we would estimate an annual average of 18.4 Atlantic sturgeon impinged at IP2 and IP3.

Because of the uncertainty related to the factors associated with impingement rates, it is difficult to determine which estimate is a better predictor of future impingement. The Entergy methodology assumes an 80% reduction in impingement in the future as compared to the time when monitoring took place. Based on comparisons of CPUE from 1985-1990 as compared to 2007-2011, it appears that at 73% reduction may be more reasonable. When we reduce our expected annual average impingement of 18.4 by 73%, we result in a calculated average annual impingement of 13.4 Atlantic sturgeon per year. The major difference in these two estimates is that our estimate considers that the juvenile Atlantic sturgeon population in the Hudson River shows evidence of an increasing trend. Therefore, we have considered impingement rates from 1985-1990 to be the best predictor of future impingement and have not reduced these to account for a currently low population. Entergy's estimate factors in impingement density from the 1970s when impingement rates were very high but then applies an overall 80% reduction to the impingement rates. Those differences in methodology accounts for the differences in our predicted annual impingement. However, we believe that our estimate is a reasonable predictor of future Atlantic sturgeon impingement. This estimate is based on the annual average estimate of 11.5 Atlantic sturgeon per year during the period of 1985-1990 and a 160% increase to account for increases in the predicted amount of water to be withdrawn in the future as compared to 1976-1990. Using the calculation discussed previously for IP1, we expect the annual average impingement of 0.04 Atlantic sturgeon at the IP1 intakes.

Between now and September 23, 2033 when the proposed renewed operating license for IP2 will expire, we expect up to 269 Atlantic sturgeon will be impinged at the IP2 intakes (Ristroph screens), inclusive of 2 Atlantic sturgeon impinged at the IP1 intakes used for IP2 service water. Between now and December 12, 2035 when the proposed renewed operating license for IP3 will expire, we expect up to 145 Atlantic sturgeon will be impinged at the IP3 intakes (Ristroph screens). In total, if both facilities operate until the expiration dates of the proposed renewed licenses, up to 414 Atlantic sturgeon will be killed as a result of Indian Point operations.

Consistent with the period when monitoring was ongoing, we expect the number of impingements to be variable year to year. Adjusting the annual impingement values from 1985-1990 using the methodology outlined above to account for differences in population size and increased water withdrawal, we expect that annual impingement values will range from zero to 71 Atlantic sturgeon per year. Adjusting the annual impingement values from 1985-1990 using the methodology outlined above to account for differences in increased water withdrawal (i.e., multiplying the estimated impingement value by 1.6), we expect that annual impingement values will range from zero to 71 Atlantic sturgeon per year at IP2 and IP3, collectively (range of 0-31 at IP2 and 0-40 at IP3). However, over time, we expect the average to be 13 Atlantic sturgeon impinged per year at the IP2 Ristroph screens and 6 at the IP3 Ristroph screens. We also anticipate that there will be no more than two consecutive years where there are more than 10 impingements at IP2 and no more than two consecutive years where there are more than 10 impingements at IP3. For example, we do not anticipate that there would ever be more than 31 Atlantic sturgeon impinged at IP2 in any given year or 11 (or more)Atlantic sturgeon impinged at IP2 in any three consecutive years. Similarly, for IP3 we do not anticipate the impingement of more than 40 Atlantic sturgeon in any given year or 11 (or more) Atlantic sturgeon impinged at IP3 in any three consecutive years.

Our calculations are illustrated below:

a) Average annual impingement 1985-1990: 11.5
b) Account for increased water usage by multiplying 11.5 by 160% = 18.4 rounded up to 19
c) During 1985-1990, 33% of reported impingement of Atlantic sturgeon occurred at IP2. Annually we then expect 33% of 19 impingements to occur at IP3 = 13 at IP2 and 6 at IP3
d) IP1 withdraws 0.34% of the water withdrawn by IP2 and IP3. Expect 0.34% of total impingement at IP1. (0.0034 x 19) = .006 annually; water will be withdrawn through the IP1 intakes for 21 years. 0.006 x 21 = 1.36, rounded up to 2
e) Based on license dates, we expect IP2 to operate from now until September 28, 2033, a total of 21 years. Adjusting the annual average impingement for IP2 and IP3 (19) to account for the % of impingements we expect at IP2 (67%) times 21 years = 267 Atlantic sturgeon plus two at IP1 = 269 at an average rate of 13 per year.
f) Based on license dates, we expect IP3 to operate from now until December 12, 2035, a total of 23 years. Adjusting the annual average impingement for IP2 and IP3 (19) to account for the % of impingements we expect at IP2 (33%) times 23 years = 145 Atlantic sturgeon, at an average rate of 6 per year.
g) In total, we expect 414 Atlantic sturgeon to be impinged at the IP1, IP2 and IP3 intakes, with an average annual impingement rate of 19 Atlantic sturgeon for the 21 years IP2 and IP3 are operational and an annual average impingement rate of 6 shortnose sturgeon for the 2 years only IP3 is operational.

As explained in section 4.2.2, we have determined that Atlantic sturgeon in the action area likely originate from three of the five DPSs at the following frequencies: NYB 92%; Gulf of Maine 6%; and, Chesapeake Bay 2%. However, it is important to note that only subadults and adults leave their natal rivers. Therefore, any young of the year or juveniles that are impinged would originate from the Hudson River and the New York Bight DPS. We can identify the life stage of Atlantic sturgeon by length. Subadults may move to coastal waters once reaching lengths of approximately76-92 cm (Murawski and Pacheco 1977; Smith 1985).

From 1985 through 1990, lengths (mm total length, "mmTL") and weights (wet weight in grams) of impinged Atlantic sturgeon were reported at IP2 and IP3; however, from 1974-1984, weights were reported but lengths were not. Therefore, for 1974-1984, Entergy predicted lengths of impinged Atlantic sturgeon based on reported weights of impinged Atlantic sturgeon. The prediction equation (R^2=0.85) was developed from length and weight measurements obtained from 36 Atlantic sturgeon collected during impingement sampling from 1985-1990 (Figure 9 below).

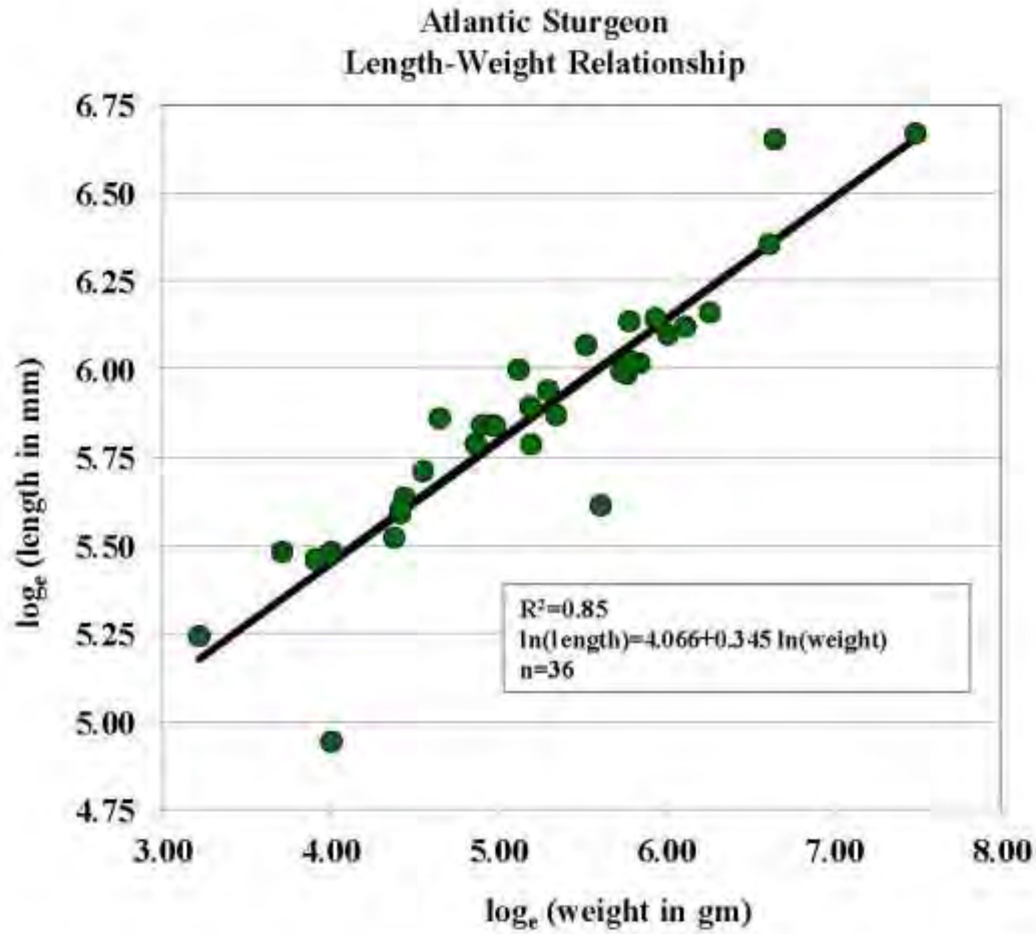


Figure 9. Atlantic sturgeon length-weight relationship based on length (mm TL) and weight measurements (dots) recorded on 36 Atlantic sturgeon collected during impingement sampling at IP2 and IP3 from 1985-1990.

In addition, measurements on greatest body width (mm) and depth (mm) from Atlantic sturgeon collected in FSS and striped bass mark-recapture sampling programs from July through December 2011 were used to predict the longest Atlantic sturgeon that would fit through the 3" wide opening of the bar racks, and could be impinged at IP2 or IP3. Applying this approach, the longest Atlantic sturgeon that would not be excluded by the bar racks, i.e., that could fit between the bars regardless of orientation, would be approximately 600 mmTL.

The length frequency distributions for impinged Atlantic sturgeon (Figure 9) show a median length of approximately 330 mmTL, with a 10th percentile of approximately 200 mmTL and a 90th percentile of approximately 500 mmTL. Although the median length of Atlantic sturgeon collected by 35 foot otter trawls in the Hudson River in 1978 was almost 600mm (Dovel and Berggren, 1980), only 2.5% of impinged Atlantic sturgeon were greater than 600 mmTL, which supports the conclusion that Atlantic sturgeon larger than 600 mmTL are excluded from impingement on the Ristroph screens by the bar racks.

Of the 36 impinged Atlantic sturgeon where length was recorded, only two were longer than 76cm and could have been migrants from outside the Hudson River. However, given their size (77 and 78 cm) at the low end of the range at which coastal migrations begin (76-92 cm) and the time of year that they were impinged (February 14 and March 13) it is likely that these two fish originated from the Hudson River.

Based on the available information on past impingements and the predicted size of individuals that will be impinged in the future, it is likely that all impingements at the screens will be of young of year, juveniles and subadults originating from the Hudson River. Therefore, we expect all individuals impinged at the screens will originate from the New York Bight DPS.

We cannot predict the number of Atlantic sturgeon likely to be impinged at the IP trash racks. However, based on the available information, we expect all of these Atlantic sturgeon to be dead or stressed, with the cause of death/stressor currently unknown. Because these individuals are likely to be subadults or adults, they could originate from the New York Bight, Gulf of Maine or Chesapeake Bay DPS.

Predicted Mortality of Impinged Atlantic Sturgeon

NRC has stated that the installation of the modified Ristroph screens following the 1987-1990 monitoring period is expected to have reduced impingement mortality for sturgeon. However, because no monitoring occurred after the installation of the Ristroph screens and more recent data are not available, it is not possible to determine to what extent the modified Ristroph screens may have reduced impingement mortality as compared to pre-1991 levels.

Of the 601 Atlantic sturgeon collected during impingement sampling at IP2 and IP3, condition (alive or dead) is reported for 37 fish (NRC BA 2012); of these, 22 are reported as dead (59% mortality rate). There is no information to indicate whether alive meant alive and not injured, or alive and injured. There is also no additional information to assess whether these fish reported as dead were likely killed prior to impingement and drifted into the intake or whether being in the intake bays and/or impingement was the sole cause of death or a contributing cause of death.

Before installation of modified Ristroph screen systems in 1991, 100 percent impingement mortality at IP2 and IP3 was assumed. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design of the screens, as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at IP2 and IP3. The Fletcher study reported mortality following an 8-hour holding period in an attempt to account for delayed mortality that may result from injuries suffered during impingement. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad, with mortality rates ranging from 9-62%, depending on species. No evaluation of survival of Atlantic sturgeon on the modified Ristroph screens at IP2 or IP3 was made and no monitoring has occurred since the screens were installed in 1991. No Atlantic sturgeon were observed during the limited monitoring that occurred at the modified Ristroph screens. As discussed in section 7.2.1.1 above, there are several reasons why we are unable to rely on any reported increase in survival for the modified screens or use the survival rates for other species to predict survival of sturgeon. This is because (1) none of these tests used sturgeon; (2) the species considered in the monitoring and testing are not morphologically similar to sturgeon and are considerably smaller than the larger sturgeon that could pass through the trash bars and be impinged at the Ristroph screens, and (3) there are no studies comparing impingement mortality or likelihood of injury of sturgeon compared to other species at any intake screens that could be used to estimate mortality rates for sturgeon based on the rates for other species.

No further monitoring of the IP2 or IP3 intakes or impingement rates or impingement mortality estimates was conducted after the new Ristroph screens were installed at IP2 and IP3 in 1991, and any actual reduction in mortality or injury to Atlantic sturgeon resulting from impingement after installation of these systems at IP2 and IP3 has not been established. As explained above, Atlantic sturgeon with a body width of at least three inches would not be able to pass through the trash bars and would become impinged on the trash bars and not pass through to the Ristroph screens. Survival for Atlantic sturgeon impinged on the trash bars would be dependent on the length of time the fish was impinged and whether it also interacted with debris that collects on the bars. Assuming that shortnose and Atlantic sturgeon mortality rates are similar, we expect that the mortality of Atlantic sturgeon at the trash barsis likely to be high (e.g., 85% for shortnose sturgeon at Salem nuclear facility) even when a monitoring program is in place designed to observe and remove impinged fish.

As noted above, healthy Atlantic sturgeon (yearlings and older) are expected to be able to readily avoid an intake with an approach velocity of 1.0 fps or less. Therefore, any Atlantic sturgeon impinged at the trash bars, where the velocity is 1.0 fps or less depending on operating condition, are likely to already be suffering from injury or illness which has impaired their swimming ability and are likely to be dead or stressed with the cause of death/stressor currently unknown.

Based on the available information, it is difficult to predict the likely mortality rate for Atlantic sturgeon following impingement on the Ristroph screens. Atlantic sturgeon passing through the trash bars and becoming impinged on the Ristroph screens are likely to be small juveniles or subadults with body widths less than three inches. Based on the 8-hour survival rates reported by Fletcher for other species, it is likely that some percentage of Atlantic sturgeon impinged on the Ristroph screens will survive. Some Atlantic sturgeon that become impinged on the Ristroph screens are likely to be suffering from injuries, illnesses, or other stressors that have impaired their swimming ability and prevented them from being able to escape from the relatively low reported approach velocity (1.0 fps or less as measured within the intake bay in front of the Ristroph screens, which yearling and older Atlantic sturgeon are expected to be able to avoid. Given the design of the Ristroph screens and the short passage time, it is unlikely that passage through the screen system would increase the likelihood of mortality or exacerbate injury or illness. However, because we do not know the condition of the fish prior to impingement, and we have no site-specific studies to base an estimate or even species-specific studies at different facilities, we will assume the worst case, that mortality is 100%.

Using the impingement rates calculated above, and the worst case mortality rate of 100% at the modified Ristroph screens, we expect a total of 414 Atlantic sturgeon to die as a result of impingement at IP1, IP2 and IP3 between now and the time that the extended operating licenses expire (2 at IP1, 267 at IP2 and 145 at IP3). For the reasons given above, we believe that the 100% mortality estimate is a conservative, yet reasonable, mortality rate for impinged Atlantic sturgeon at the trash bars and Ristroph screens. As noted above, we expect all impinged Atlantic sturgeon to originate from the Hudson River and the New York Bight DPS. Therefore, we expect the mortality of 414 juvenile New York Bight DPS Atlantic sturgeon between now and December 12, 2035. We can not predict the number of Atlantic sturgeon likely to be impinged at the IP trash racks. However, based on the available information, we expect all of these shortnose sturgeon to be dead or stressed, with the cause of death/stressor currently unknown.

7.1.3 Effects of Impingement and Entrainment on Shortnose and Atlantic sturgeon prey

Shortnose and Atlantic sturgeon feed primarily on benthic invertebrates. As these prey species are found on the bottom and are generally immobile or have limited mobility and are not within the water column, they are less vulnerable to impingement or entrainment. Impingement and entrainment studies have not included macroinvertebrates as focus species. No macroinvertebrates are represented in the Representative Important Species (RIS) species focused on by NRC in the FSEIS. However, given the life history characteristics (sessile, benthic, not suspended in or otherwise occupying the water column) of shortnose and Atlantic sturgeon forage items which make impingement and entrainment unlikely, any loss of sturgeon prey due to impingement or entrainment is likely to be minimal. Therefore, we have determined that the effect on shortnose and Atlantic sturgeon due to the potential loss of forage items caused by impingement or entrainment in the IP1, IP2 or IP3 intakes is insignificant and discountable.

7.1.4 Summary of Effects of Water Withdrawal

IP2 and IP3 currently operate pursuant to operating licenses issued by NRC; this will continue until a licensing decision is made. If new licenses are issued as proposed, IP2 and IP3 will continue to operate with once through cooling until September 28, 2033 and December 12, 2035 respectively.

In the analysis outlined above, we determined the impingement of shortnose sturgeon is likely to occur at IP2 and IP3 while IP2 and IP3 continue to operate as well as at the IP1 intake which will be used for withdrawing service water for the operation of IP2. We estimate, using the impingement and mortality rates calculated above, that each year an average of 26 shortnose sturgeon will die as a result of impingement at the screens at the Indian Point facilities, for a total of 562 shortnose sturgeon mortalities caused by the operations of Indian Point between now and December 12, 2035 (2 at IP1, 393 at IP2 and 167 at IP3) . We also estimate that an average of 19 Atlantic sturgeon will be impinged and die each year, for a total of 414 Atlantic sturgeon mortalities caused by the operations of Indian Point between now and December 12, 2035 (2 at IP1, 267 at IP2 and 145 at IP3). All of these Atlantic sturgeon are likely to originate from the Hudson River and the New York Bight DPS. We believe that the 100% mortality estimate is a conservative, yet reasonable estimate of the likely mortality rate for impinged shortnose sturgeon at the screens. Additionally, we anticipate the impingement of dead or stressed shortnose sturgeon, New York Bight DPS, Gulf of Maine DPS and Chesapeake Bay DPS Atlantic sturgeon with body widths greater than 3” at the IP1, IP2 and IP3 trash bars. The cause of death/stressor of these sturgeon impinged at the trash bars is currently unknown. Due to the size of shortnose and Atlantic sturgeon that occur in the action area, no entrainment at any of the IP intakes is anticipated. Any effects to shortnose or Atlantic sturgeon prey from the continued operation of IP2 and IP3, as defined by the proposed action, would be insignificant and discountable.

7.2 Effects of Discharges to the Hudson River

The discharge of pollutants from the IP facility is regulated for CWA purposes through the New York SPDES program. The SDPES permit (NY-0004472) specifies the discharge standards and monitoring requirements for each discharge. Under this regulatory program, Entergy treats wastewater effluents, collects and disposes of potential contaminants, and undertakes pollution prevention activities.   As currently configured, IP2 and IP3 cannot operate without withdrawing water from and discharging water to the Hudson River. Therefore, effects of the continued operation of IP2 and IP3 include the discharge of effluent to the Hudson River.
As explained above, Entergy's 1987 SPDES permit remains in effect while NYDEC administrative proceedings continue on a new draft permit. As such, pursuant to NRC's consultation request, the effects of the IP facility continuing to operate under the terms of the existing licenses and the proposed renewed licenses and under the terms of the 1987 SPDES permit will be discussed below.

7.2.1 Heated Effluent

As indicated above, the extended operation of IP2 and IP3 will be regulated by the NRC through the issuance of renewed operating licenses. Given the facilities with a once-through cooling water system cannot operate without the intake and discharge of water, the effects of discharges are effects of the proposed action. This is also true for the existing licenses under which the facility will operate until NRC makes a licensing decision. The discharges would not occur but for the operation of the facilities.

Thermal discharges associated with the operation of the once through cooling water system for IP2 and IP3 are regulated for CWA purposes by the terms of the SPDES permit. Temperature limitations are established and imposed on a case-by-case basis for each facility subject to NYCRR Part 704.   Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR Part 704 as follows:

(5) Estuaries or portions of estuaries.

i. The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point.
ii. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or a maximum of 83°F, whichever is less.
iii. From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than an 83°F increase in temperature not to exceed 1.5°F at any point of the estuarine passageway as delineated above, may be permitted.
iv. At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than 4°F from the temperature that existed immediately prior to such lowering.

Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified by NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110°F (43°C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2°F (34°C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2°F (34°C) on more than 15 days during that period in any year.

The discharge of heated water has the potential to cause lethal or sublethal effects on fish and other aquatic organisms and create barriers, preventing or delaying access to other areas within the river. Limited information is available on the characteristics of the thermal plume associated with discharges from IP2 and IP3. As water withdrawn through the IP1 intakes will be used for service water, not cooling water, the discharge of this water is not heated. Below, NMFS summarizes the available information on the thermal plume, discusses the thermal tolerances of shortnose sturgeon, and considers effects of the plume on shortnose sturgeon, Atlantic sturgeon and their prey.

7.2.1.1 Characteristics of Indian Point's Thermal Plume

Thermal studies at IP2 and IP3 were conducted in the 1970s. These studies included thermal modeling of near-field effects using the Cornell University Mixing Zone Model (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology (MIT) dynamic network model (also called the far-field thermal model). For the purpose of modeling, near-field was defined as the region in the immediate vicinity of each station discharge where cooling water occupies a clearly distinguishable, three-dimensional temperature regime in the river that is not yet fully mixed; far-field was defined as the region farthest from the discharges where the plumes are no longer distinguishable from the river, but the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed sufficient by the utilities and their contractor and was designed and configured to account for time-variable hydraulic and meteorological conditions and heat sources of artificial origins. Model output included a prediction of temperature distribution for the Hudson River from the Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the permit applicants applied CORMIX modeling to develop a three-dimensional plume configuration of near-field thermal conditions that could be compared to applicable water quality criteria.

The former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September. These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

i. Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.
ii. Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each station, and concurrent operation of all three generating stations at maximum permitted capacity (CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX model runs were integrated with the riverwide temperature profiles developed by the MIT dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises above ambient) for various operating scenarios, the surface width of the plume, the depth of the plume, the percentage of surface width relative to the river width at a given location, and the percentage of cross-sectional area bounded by the 4°F (2°C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999). For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86°F (1.18 to 1.59°C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4°F (2°C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24°F (1.80°C) during June ebb tides to 4.63°F (2.57°C) during flood tides in August. Temperature increases exceeded 4°F (2°C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4°F (2°C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events.

Exceedences generally occurred under scenarios that Entergy indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding, CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

Information provided by Entergy during the consultation period indicates that the CORMIX model has significant limitations which limit its utility when considering the discharge of heated effluent into the Hudson River. Specifically, the CORMIX model results in an overestimate of the scope and extent of the thermal plume. As more recent information on the thermal plume is available (see below) and this new information has been reviewed by NYDEC and determined to be appropriate to use when considering the effects of the thermal discharge on the Hudson River, NMFS is not relying on the CORMIX model in our effects analysis, but rather is relying on the more recent triaxial thermal plume study described below.

More recently, a triaxial thermal plume study was completed. Swanson et al. (2011 b) conducted thermal sampling and modeling of the cooling water discharge at Indian Point and reported that the extent and shape of the thermal plume varied greatly, primarily in response to tidal currents. For example, the plume (illustrated as a 4°F temperature increase or LH isotherm, Figure 5-6 in Swanson et al. 2011 b) generally followed the eastern shore of the Hudson River and extended northward from Indian Point during flood tide and southward from Indian Point during ebb tide. Depending on tides, the plume can be well-defined and reach a portion of the near-shore bottom or be largely confined to the surface.

Temperature measurements reported by Swanson et al. (2011 b) generally show that the warmest water in the thermal plume is close to the surface and plume temperatures tend to decrease with depth. Occasionally, the thermal plume extends deeply rather than across the surface. A cross-river survey conducted in front of Indian Point captured one such incident during spring tide on July 13, 2010 (Figure 3-28 in Swanson et al. 2011b). Across most of the river, water temperatures were close to 82°F (28°C), often with warmer temperatures near the surface and cooler temperatures near the bottom. The Indian Point thermal plume at that point was clearly defined and extended about 1000 ft (300 m) from shore. Surface water temperatures reached about 85°F (29°C). At 23-ft to about 25-ft (7-m to 8-m) depths, observed plume temperatures were 83° to 84°F (28° to 29°C). Maximum river depth along the measured transect is approximately 50 ft (15 m).

A temperature contour plot of a cross-river transect at Indian Point prepared in response to a NYSDEC review illustrates a similar condition on July 11, 2010 during slack before flood tide (Swanson et al. 2011a, Figure 1-10). Here the thermal plume is evident to about 2000 ft (600 m) from the eastern shore (the location of the Indian Point discharge) and extends to a depth of about 35 ft (11 m) along the eastern shore. Bottom temperatures above 82°F (28°C), were confined to about the first 250 ft (76 m) from shore. The river here is over 4500 ft (1400 m) wide. In that small area, bottom water temperatures might also exceed 30°C (86°F); elsewhere, bottom water temperatures were about 80°F (27°C). These conditions would not last long, however, as they would change with the tidal cycle. Under no conditions did interpolated temperatures in Entergy's modeled results exceed the 28°C in the deep reaches of the river channel (Swanson 2011 a).

In response to the NYSDEC's review of the Indian Point thermal studies (Swanson et al. 2011 b), Mendelsohn et al. (2011) modeled the maximum area and width of the thermal plume (defined by the 4°F (2°C) ΔT isotherms) in the Hudson River. Mendelsohn, et al. reported that for four cross-river transects near IP2 and IP3, the maximum cross-river area of the plume would not exceed 12.3 percent and the maximum cross-river width of the plume would not exceed 28.6 percent of the river (Mendelsohn, et al.'s Table 3-1).

7.2.1.2 Thermal Tolerances – Shortnose sturgeon
Most organisms can acclimate (i.e. metabolically adjust) to temperatures above or below those to which they are normally subjected. Bull (1936) demonstrated, from a range of marine species, that fish could detect and respond to a temperature front of 0.03 to 0.07°C (0.05 – 0.13°F). Fish will therefore attempt to avoid stressful temperatures by actively seeking water at the preferred temperature.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F)(Dadswell et al. 1984) and as high as 27-30°C in the Connecticut River (Dadswell et al. 1984) and 34ºC in the Altamaha River, Georgia (93.2°F) (Heidt and Gilbert 1978). Foraging is known to occur at temperatures greater than 7°C (44.6°F) (Dadswell 1979). In the Altamaha River, temperatures of 28-30ºC (82.4-86°F) during summer months are correlated with movements to deep cool water refuges. Some information specific to the Hudson River is available. Smith (1985 in Gilbert 1989) reports that juvenile Atlantic sturgeon were most common in areas where water temperatures were 24.2-24.7°C. Haley (1999) conducted studies on the distribution of Atlantic and shortnose sturgeon in the Hudson River in 1995 and 1996. Water temperatures at capture locations were recorded. Atlantic sturgeon were found in warmer areas than shortnose sturgeon. The mean temperature of areas where Atlantic sturgeon were present was 25.6°C (s.d. +/- 2.0); the mean temperature for shortnose sturgeon was 24.34°C (s.d. +/- 2.8°C.

Ziegeweid et al. (2008a) conducted studies to determine critical and lethal thermal maxima for young-of-the-year (YOY) shortnose sturgeon acclimated to temperatures of 19.5 and 24.1°C (67.1 – 75.4°F). These studies were carried out in a lab with fish from the Warm Springs National Fish Hatchery (Warm Springs, Georgia). The fish held at this fish hatchery were reared from broodstock collected from the Altamaha and Ogeechee rivers in Georgia. Lethal thermal maxima were 34.8°C (±0.1) and 36.1°C (±0.1) (94.6°F and 97°F) for fish acclimated to 19.5 and 24.1°C (67.1°F and 75.4°F), respectively. The acclimation temperature of 24.1°C is similar to the temperature where shortnose and Atlantic sturgeon juveniles were most often found in the Hudson River (24.1°C) suggesting that this it is reasonable to rely on these results for assessing effects to Hudson River sturgeon. However, it is important to note that there may be physiological differences in sturgeon originating from different river systems. Fish originating from southern river systems may have different thermal tolerances than fish originating from northern river systems. However, the information presented in this study is currently the best available information on thermal maxima and critical temperatures for shortnose sturgeon. The study also used thermal maximum data to estimate upper limits of safe temperature, final thermal preferences, and optimum growth temperatures for YOY shortnose sturgeon. Visual observations suggest that fish exhibited similar behaviors with increasing temperature regardless of acclimation temperature. As temperatures increased, fish activity appeared to increase; approximately 5–6°C (9-11°F) prior to the lethal endpoint, fish began frantically swimming around the tank, presumably looking for an escape route. As fish began to lose equilibrium, their activity level decreased dramatically, and at about 0.3°C (0.54°F)before the lethal endpoint, most fish were completely incapacitated. Estimated upper limits of safe temperature (ULST) ranged from 28.7 to 31.1°C (83.7-88°F) and varied with acclimation temperature and measured endpoint. Upper limits of safe temperature (ULST) were determined by subtracting a safety factor of 5°C (9°F) from the lethal and critical thermal maxima data. Final thermal preference and thermal growth optima were nearly identical for fish at each acclimation temperature and ranged from 26.2 to 28.3°C (79.16-82.9°F). Critical thermal maxima (the point at which fish lost equilibrium) ranged from 33.7 (±0.3) to 36.1°C (±0.2) (92.7-97°F) and varied with acclimation temperature. Ziegeweid et al. (2008b) used data from laboratory experiments to examine the individual and interactive effects of salinity, temperature, and fish weight on the survival of young-of-year shortnose sturgeon. Survival in freshwater declined as temperature increased, but temperature tolerance increased with body size. The authors conclude that temperatures above 29°C (84.2°F) substantially reduce the probability of survival for young-of-year shortnose sturgeon. However, previous studies indicate that juvenile sturgeons achieve optimum growth at temperatures close to their upper thermal survival limits (Mayfield and Cech 2004; Allen et al. 2006; Ziegeweid et al. 2008a), suggesting that shortnose sturgeon may seek out a narrow temperature window to maximize somatic growth without substantially increasing maintenance metabolism. Ziegeweid (2006) examined thermal tolerances of young of the year shortnose sturgeon in the lab. The lowest temperatures at which mortality occurred ranged from 30.1 – 31.5°C (86.2-88.7°F) depending on fish size and test conditions. For shortnose sturgeon, dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

7.2.1.3 Thermal Tolerances – Atlantic sturgeon

Limited information on the thermal tolerances of Atlantic sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall *et al.* 2010). In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). These tests were carried out with fish reared at the US Fish and Wildlife Service's Northeast Fishery Center (Lamar, PA) and are progeny of Hudson River broodstock. Thus, it is reasonable to rely on results of this study when considering thermal tolerances of Atlantic sturgeon in the Hudson River.

Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.*. 2008 and Jenkins *et al.*. 1993); however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. For purposes of considering effects of thermal tolerances, shortnose sturgeon are a reasonable surrogate for Atlantic sturgeon given similar geographic distribution and known biological similarities.

7.2.1.4 Effect of Thermal Discharge on Shortnose and Atlantic Sturgeon

The lab studies discussed in Section 7.2.1.2 above, indicate that thermal preferences and thermal growth optima for shortnose sturgeon range from 26.2 to 28.3°C (79.2-83°F). This is consistent with field observations which correlate movements of shortnose sturgeon to thermal refuges when river temperatures are greater than 28°C (82.4°F) in the Altamaha River. Lab studies (see above; Ziegeweid et al. 2008a and 2008b) indicate that thermal maxima for shortnose sturgeon are 33.7 (±0.3) – 36.1(±0.1) (92.7-97°F), depending on endpoint (loss of equilibrium or death) and acclimation temperature (19.5 or 24.1°C). Upper limits of safe temperature were calculated to be 28.7 – 31.1°C (83.7-88°F). At temperatures 5-6°C (9-11°F) less than the lethal maximum, shortnose sturgeon are expected to begin demonstrating avoidance behavior and attempt to escape from heated waters; this behavior would be expected when the upper limits of safe temperature are exceeded. For purposes of this consultation, we will consider these threshold temperature values to also apply to Atlantic sturgeon.

We first consider the potential for sturgeon to be exposed to temperatures which would most likely result in mortality. To be conservative, we considered mortality to be likely at temperatures that are expected to result in loss of equilibrium (33.7±0.3 for fish acclimated to temperatures of 19.5°C and 36.1±0.2 for fish acclimated to temperatures of 24.1°C). As noted above, shortnose and Atlantic sturgeon in the Hudson River are most often found in areas where temperatures are approximately 24°C suggesting that use of temperatures for fish acclimated to temperatures of 24.1°C is reasonable.

The maximum observed temperature of the thermal discharge is approximately 35°C (95°F). Modeling has demonstrated that the surface area of the river affected by the Indian Point plume where water temperatures would exceed 32.22°C (90°F) would be limited to an area no greater than 75 acres. Information provided by Entergy and presented in the recent thermal model (Swanson et al. 2011) indicate that water temperatures will not exceed 32.2°C (90°F) in waters more than 5 meters (16.4 feet) from the surface. Because 32.22°C is below the temperature that would result in a loss of equilibrium, we do not expect loss of equilibrium or death to fish exposed to this temperature. Water depths in the area are approximately 18 meters (59 feet) meaning that there should be 13 meters of water column with water temperatures below 32.22°C. Given this information, it is unlikely that shortnose or Atlantic sturgeon remaining near the bottom of the river or even in the middle of the water column would be exposed to water temperatures of 33.7°C (92.7°F). Temperatures at or above 33.7°C (92.7°F) will occasionally be experienced at the surface of the river in areas closest to the discharge point. Shortnose and Atlantic sturgeon are known to move to deep cool water areas during the summer months in southern rivers. Laboratory studies using shortnose sturgeon (progeny from Savannah River broodstock) and Atlantic sturgeon (progeny from Hudson River broodstock) demonstrate that these species are able to identify and select between water quality conditions that significantly affect growth and metabolism, including temperature. Based on field observations and laboratory studies, we expect that sturgeon would actively avoid areas where temperatures are intolerable. Assuming that there is a gradient of temperatures decreasing with distance from the outfall (as illustrated in Swanson et al. 2011), we expect shortnose and Atlantic sturgeon to begin avoiding areas with temperatures greater than 28°C (82.4°F). We do not expect individuals to remain within the heated surface waters to swim towards the outfall and be exposed to temperatures which could result in mortality. As such, provided that conditions allow for sturgeon to detect changes in temperature (i.e., that there is a gradual gradient of temperatures decreasing with increasing distance from the outfall as reported in Swanson et al. 2011) and escape from the area prior to prolonged exposure to critical temperatures, it is extremely unlikely that any sturgeon would remain within the area where surface temperatures are elevated to 33.7°C (92.7°F) and be exposed to potentially lethal temperatures. This gradient of temperatures that decreases from the surface to the bottom is also expected to deter sturgeon from moving high enough up into the water column to encounter surface waters that have stressful or lethal temperatures. Tis risk is further reduced by the limited amount of time shortnose and Atlantic sturgeon spend near the surface, the small area where such high temperatures will be experienced and the gradient of warm temperatures extending from the outfall. Near the bottom where shortnose and Atlantic sturgeon most often occur, water temperatures are not likely to ever reach 33.7°C (92.7°F), creating no risk of exposure to temperatures likely to be lethal near the bottom of the river. It is important to note that this analysis is dependent on the assumption that exposure to increased temperatures will be gradual; that is, we do not anticipate that sturgeon would be exposed to rapid changes in water temperature. Information provided by Entergy confirms that there are no rapid changes in water temperature associated with routine operations, during outages and restarts or during pump speed adjustment (Entergy 2012b). As noted in Ziegweid (2008a), heating rate is a factor in determining critical maxima (loss of equilibrium and mortality). In order for there to be a loss of equilibrium or mortality a fish must be exposed to the heat source long enough for deep body temperatures to equal water temperatures. However, Ziegweid does not provide any indication of the length of time fish were exposed to critical temperatures before loss of equilibrium or mortality would occur. He does note, however, that larger fish will take longer to "heat up" than smaller fish.

We have also considered the potential for shortnose and Atlantic sturgeon to be exposed to water temperatures greater than 28°C (82.4°F). Available information from field observations (primarily in southern systems; however this may be related to the prevalence of temperatures greater than 28°C in those areas compared to the rarity of ambient temperatures greater than 28°C in northern rivers) and laboratory studies (using progeny of fish from southern and northern rivers) suggests that water temperatures of 28°C (82.4°F) or greater can be stressful for sturgeon and that shortnose and Atlantic sturgeon are likely to actively avoid areas with these temperatures. This temperature (28°C; (82.4°F)) is close to both the final thermal preference and thermal growth optimum temperatures that Ziegeweid et al. (2008) reported for juvenile shortnose sturgeon acclimated to 24.1 °C (75.4 °F), and thus is consistent with observations that optimum growth temperatures are often near the maximum temperatures fish can endure without experiencing physiological stress. Based on the available information, it is reasonable to anticipate that shortnose and Atlantic sturgeon will actively avoid areas with temperatures greater than 28°C.

In the summer months (June – September) ambient river temperatures can be high enough that temperature increases as small as 1-4°C (1.8-7.2°C) would cause water temperatures within the plume to be high enough to be avoided by shortnose and Atlantic sturgeon (greater than 28°C (82.4°F)). When ambient river temperatures are at or above 28°C (82.4°F), the area where temperatures are raised by more than 1.5°C (2.7°F) are expected to be limited to a surface area of up to 75 acres. Shortnose and Atlantic sturgeon exposure to the surface area where water temperature would be elevated above 28°C (82.4°F) due to the influence of the thermal plume is limited by their normal behavior as benthic-oriented fish, which results in limited occurrence near the water surface. Assuming that there is a gradient of water temperatures that decreases with increasing distance from the outfall and decreases with depth from the surface, any surfacing shortnose or Atlantic sturgeon are likely to detect the increase in water temperature and swim away from near surface waters with temperatures greater than 28°C (82.4°F). Reactions to this elevated temperature are expected to consist of swimming away from heated surface waters by traveling deeper in the water column or by swimming around bottom waters heated by the plume.

Swanson (2011a) presents vertical section views of temperature contours. These contours were created using numerous interpolation techniques on actual measured temperatures at 66 moorings deployed near Indian Point. Under no conditions did interpolated exceed 28°C (82°F) in the deep reaches of the river channel (Swanson 2011 a) where shortnose sturgeon are most likely to occur. Swanson also examined other sources of available bottom water temperature data for the Indian Point area. Based upon examination of the 1997 through 2010 long river survey water temperature data from the near-bottom stations near Indian Point, 28°C (82.4°F) was exceeded for just 56 of 1,877 observations or 2.98% during this 14-year period (readings measured weekly from March through November). These already low incidences of observed near-bottom water temperatures above 28°C (82.4°F) would be even lower when viewed in the context of an entire year instead of the nine months sampled due to the cold water period not sampled from December through February (i.e., 2.24% for the Indian Point region).

The available information on the thermal plume indicates that water temperature at the bottom of the river will be elevated to above 28°C only rarely (approximately 2.24% of the time). We expect that sturgeon will avoid bottom waters where temperatures are greater than 28°C. Sturgeon in the action area are likely to be foraging, resting or migrating. Disruptions to these behaviors will be limited to moving away from the area with stressful temperatures. Given the small area that would have temperatures elevated above 28°C (82.4°F) it is extremely unlikely that these minor changes in behavior will preclude shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

Given that shortnose and Atlantic sturgeon are known to actively seek out cooler waters when temperatures rise to 28°C (82.4°F), any shortnose sturgeon encountering bottom waters with temperatures above 28°C (82.4°F) area are likely to avoid it. Reactions to this elevated temperature are expected to be limited to swimming away from the plume by swimming around it. Given the extremely small percentage of the estuary that would have temperatures elevated above 28°C (82.4°F) and the limited spatial and temporal extent of any elevations of bottom water temperatures above 28°C (82.4°F), it is extremely unlikely that these minor changes in behavior will preclude any shortnose or Atlantic sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

We have considered whether avoidance of the thermal plume would affect the likelihood of impingement at the intakes. The intakes are located upstream of the discharge canal. During ebb tides, the thermal plume is largely directed downstream; at flood tide the area of stressful temperatures can overlap the intake area. The thermal plume could influence the likelihood of impingement if sturgeon were more likely to be present near the intakes because of avoidance behavior related to the thermal plume or if sturgeon present near the intakes were suddenly overcome by discharges of warm water and lost equilibrium. Based on the available information, neither one of these scenarios seems likely. Based on illustrations of the thermal plume (see Swanson et al. 2011a and 2011b) there do not appear to be any conditions during which sturgeon would move to the intake area to seek refuge from heated waters. Sturgeon are most likely to be present in the deep channel. Considering the cross section of the river immediately adjacent to the intakes, there do not appear to be any conditions under which sturgeon would be displaced from the deepwater areas by thermal conditions and would move towards the eastern shoreline where the intakes are located. Therefore, it is not reasonable to anticipate that sturgeon that move to avoid the thermal plume would be more likely to be present near the intakes as there are adjacent deepwater areas near by as well as the area on the western side of the river that is largely unaffected by the plume. The available information on the thermal discharge indicates that there is a gradual gradient of warmed water originating from the discharge canal. Given the distance of the discharge canal from the intakes (over 200 meters (700 feet) to IP3 and over 400 meters (1,400 feet) to IP2), and our understanding of the discharge it is unlikely that water temperature changes in the river near the intake would be rapid enough to prevent sturgeon from avoiding water at temperatures that would result in impairment and a resulting increased likelihood of impingement. We also considered whether swimming to avoid the thermal plume would make sturgeon tired and less able to avoid impingement. However, because of the gradual gradient of water temperatures and the size of the plume, sturgeon will not need to swim long distances to avoid heated water. As noted above, we do not expect any energy expenditure to have any detectable effect on the physiology of any individuals. Therefore, it is unlikely that swimming to avoid the thermal plume would result in exhaustion and decreased ability to avoid the intakes.

Water temperature and dissolved oxygen levels are related, with warmer water generally holding less dissolved oxygen. As such, we considered the potential for the discharge of heated effluent to affect dissolved oxygen in the action area. Entergy provided an assessment of dissolved oxygen conditions in the vicinity of the thermal plume and nearby downstream areas. Swanson examined dissolved oxygen concentrations observed among 14 recent years (1997 through 2010) of water quality samples taken 0.3 m (1 ft) above the river bottom weekly during the Utilities Fall Shoals surveys in the Indian Point region of the Hudson River from March through November of each year. Only 17 (0.91%) dissolved oxygen concentrations below 5 mg/l were observed in the Indian Point region during this 14-year period consisting of 1,877 readings, and the lowest dissolved oxygen concentration of 3.4 mg/l occurred just once, while the remaining 16 values were between 4.4 mg/l and 4.9 mg/l. Although I/FS survey water quality sampling did not occur in the Indian Point region during the winter period from December through February of each year due to river ice conditions, it is unlikely that dissolved oxygen concentrations below 5 mg/l would be observed then due to the high oxygen saturation of the cold water in the winter. The Hudson River region south of the Indian Point region had 501 dissolved oxygen concentrations below 5 mg/l (6.33% of 7,918 total observations) in the near bottom waters, seven times more frequently than the Indian Point region. Based on this information the discharge of heated effluent appears to have no discernible effect on dissolved oxygen levels in the area. As the thermal plume is not contributing to reductions in dissolved oxygen levels, it will not cause changes in dissolved oxygen levels that could affect any shortnose or Atlantic sturgeon.

7.2.1.5 Effect on Shortnose and Atlantic Sturgeon Prey

Shortnose and Atlantic sturgeon feed primarily on benthic invertebrates; these prey species are found on the bottom. As explained above, the IP thermal plume is largely a surface plume with elevated temperatures near the bottom limited to short duration and a geographic area limited to the area close to the discharge point. No analysis specific to effects of the thermal plume on the macroinvertebrate community has been conducted. However, given what is known about the plume (i.e., that it is largely a surface plume and has limited effects on water temperatures at or near the bottom) and the areas where shortnose sturgeon forage items are found (i.e., on the bottom), it is unlikely that potential sturgeon forage items would be exposed to the effects of the thermal plume. If the thermal plume is affecting benthic invertebrates, the most likely effect would be to limit their distribution to areas where bottom water temperatures are not affected by the thermal plume. Considering that shortnose and Atlantic sturgeon are also likely to be excluded from areas where the thermal plume influences bottom water temperatures and given that those areas are small, foraging sturgeon are not likely to be affected by any limits on the distribution of benthic invertebrates caused by the thermal plume's limited influence on bottom waters. Thus, based on this analysis, it appears that the prey of shortnose or Atlantic sturgeon, would be impacted insignificantly, if at all, by the thermal discharge from IP.

7.2.2 Potential Discharge of Radionuclides to the Hudson River

Environmental monitoring and surveillance for radionuclides have been conducted at IP2 and IP3 since 1958, four years before the startup of IP1. The preoperational program was designed and implemented to determine the background radioactivity and to measure the variations in activity levels from natural and other sources in the vicinity, as well as fallout from nuclear weapons tests. The preoperational radiological data include both natural and manmade sources of environmental radioactivity. These background environmental data permit the detection and assessment of current levels of environmental activity attributable to plant operations.

The annual REMP is carried out by Entergy to monitor and document radiological impacts to the environment and the public around the IP2 and IP3 site and compare these to NRC standards. Additional sampling of fish for radionuclides captured during ongoing surveys in Harverstraw Bay will occur in 2013. Radionuclides monitored include tritium (^{3}H), strontium-90 (^{90}Sr), nickel-63, and cesium-137. Entergy summarizes the results of its REMP in an Annual Radiological Environmental Operating Report. The objectives of the IP2 and IP3 REMPs are the following: (1) to enable the identification and quantification of changes in the radioactivity of the area; and, (2) to measure radionuclide concentrations in the environment attributable to operations of the IP2 and IP3 site (NRC 2010).

The REMP at IP2 and IP3 directs Entergy to sample environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The REMP designates sampling locations for the collection of environmental media for analysis. These sampling locations are divided into indicator and control locations. Indicator locations are established near the site, where the presence of radioactivity of plant origin is most likely to be detected. Control locations are established farther away (and upwind/upstream, where applicable) from the site, where the level would not generally be affected by plant discharges or effluents. The use of indicator and control locations enables the identification of potential sources of detected radioactivity as either background or from plant operations. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents. The REMP is used to measure the direct radiation and the airborne and waterborne pathway activity in the vicinity of the IP2 and IP3 site. Direct radiation pathways include radiation from buildings and plant structures, airborne material that may be released from the plant, or from cosmic radiation, fallout, and the naturally occurring radioactive materials in soil, air, and water. The liquid waste processing system at IP2 and IP3 collects, holds, treats, processes, and monitors all liquid radioactive wastes for reuse or disposal. During normal plant operations the system receives input from numerous sources, such as equipment drains and leak lines, chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak lines, and floor drains. After it is determined that the amount of radioactivity in the wastewater is diminished to acceptable levels, the water is released into the Hudson River.

Entergy has also identified the migration of tritium to the Hudson River through groundwater pathways. In 2005, Entergy discovered a spent fuel pool water leak to groundwater while installing a new crane to facilitate transfer of Unit 2 spent fuel to dry cask storage. This leak was determined to have generated a groundwater plume of tritium (^{3}H). During efforts to track the ^{3}H plume, ^{90}Sr was discovered in a downgradient portion of the plume and traced back to a leak in the Unit 1 spent fuel pool (Skinner and Sinnott 2009). Because site groundwater flows to the Hudson River, the 2006 Radiological Environmental Monitoring Program (REMP) conducted by Entergy was modified to include ^{90}Sr as an analyte in fish samples. ^{90}Sr was detected in 4 of 10 samples of fish taken from the river in the vicinity of the Indian Point facility, and in three of five samples from an upstream reference location near the Roseton Generating Station in Newburgh, NY. The tissues analyzed were composites of edible flesh from fish representing several species. Entergy concluded that the ^{90}Sr levels were low and may be indistinguishable from background levels from fallout from nuclear weapons testing in the 1950's and 1960's (Entergy 2007). The New York State Departments of Health (NYSDOH) and NYSDEC concurred with Entergy's assessment. However, the NYSDEC and NYSDOH were concerned that the home ranges of several sampled species, and all striped bass, may overlap at the two sampling sites (Skinner and Sinnott 2009). In order to assure independence of sampling sites, the NY agencies initiated a one-time enhanced radiological surveillance for 2007 (results presented in Skinner and Sinnott 2009). The objectives of the enhanced radiological monitoring effort were to: gain information about the levels, impacts, and possible ^{90}Sr sources at the reference locations and the indicator station; determine if significant spatial differences in ^{90}Sr concentrations were present; to assess whether or not ^{90}Sr concentrations in the bones and flesh of fish signify heightened risk either to aquatic life in the Hudson River; and, provide information for an independent assessment of potential public health impacts.

The one-time design modifications for the 2007 effort included: the addition of carp (*Cyprinus carpio*) – a benthic feeder – to the target species list; adding ^{90}Sr to the list of radionuclide analytes; analysis of fish bone or crab carapace; and , sampling fish at a third location, the

Catskill Region between river miles 107 and 125. The NY agencies stated that this upstream location assures appropriate separation of fish populations that are resident to the river, and, consequently, assures isolation of resident fish populations from the potential influence of discharges from the Indian Point facility.

The study concluded that there were no apparent excursions above criteria for the protection of biota based on the radionuclide data available. The levels of radionuclides, including ^{90}Sr, were two to five orders of magnitude lower than criteria established by the US Department of Energy (USDOE 2002) for the protection of aquatic animals and freshwater ecosystems. Also, the study concluded that there were no spatial differences in concentrations of ^{90}Sr and ^{224}Ra in resident fish from the three locations sampled in the lower Hudson River (i.e., Indian Point facility, and the reference sites at the Roseton Generating Station and at Catskill). In contrast, ^{40}K levels were somewhat greater in the vicinity of Roseton Generating Station, but the differing concentrations have no known significance.

Detailed information on the radiological investigations, including groundwater, is available in the 2006-2009 REMPs. NRC indicates in the FSEIS that this multi-year period provides a representative data set that covers a broad range of activities that occur at IP2 and IP3 such as, refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities, and that effects during an extended operating period would be consistent with these sampling periods. In the FSEIS, NRC reports that tritium releases in total (groundwater as well as routine liquid effluent) represent less than 0.001% of the Federal dose limits for radioactive effluents from the site. In addition to monitoring potential effects to human health from exposure to radiation, Entergy conducts inspections of radionuclides in the environment, including fish and river sediments.

NRC has reported to NMFS that NRC has reviewed all of the available information on radionuclides and has identified no unusual trends or significant radiological impacts to the environment, including Hudson River water, river sediments and fish tissues, due to operation of the Indian Point facility. In the FSEIS, NRC states that no radioactivity distinguishable from background was detected during the most recent sampling and analysis of fish and crabs taken from the affected portion of the Hudson River and designated control locations. NRC also summarizes a 2007 NYSDEC report which concludes that strontium-90 levels in fish near the site (18.8 pCi/kg (0.69 Bq/kg)) are no higher than in those fish collected from background locations across New York State.

As explained above, additional information on potential impacts of radionuclides potentially originating from the Indian Point facility on aquatic organisms in the Hudson River is available in a recent report prepared by NYDEC (Skinner and Sinnott 2009). Neither the Skinner and Sinnott report or any of the REMPs identified radionuclide levels attributable to operation of the Indian Point facility that are at levels that are thought to negatively impact fish. It is important to note that no shortnose or Atlantic sturgeon have been tested to determine levels of radionuclides; however, as other species that have been sampled that are similarly mobile through the Hudson River have not indicated that they have radionuclide levels of concern and because expert review (NRC and NYDEC) of environmental indicators (Hudson River water, sediments, aquatic organisms) also indicates that radionuclides originating from the Hudson River, are not at levels of concern. Based on this information, while shortnose and Atlantic sturgeon could be exposed to radionuclides originating from Indian Point, as well as other sources, any exposure is not likely to be at levels that would affect the health or fitness of any individual shortnose or Atlantic sturgeon. Thus, NMFS considers the effects to shortnose and Atlantic sturgeon from radionuclides to be insignificant and discountable.

7.2.3 Other Pollutants Discharged from IP2 and IP3

The 1987 SPDES permit contains effluent limits related to an on-site sewage treatment plant, as well as cooling water discharges. The on-site sewage treatment plant is no longer operational and sanitary waste from Indian Point is now routed to the community wastewater treatment plant. Therefore, no sanitary waste discharges at the Indian Point outfalls will occur during the extended operating period. Other than the pollutants associated with sanitary wastes, pollutants limited by the 1987 SPDES permit include: total residual chlorine (TRC), lithium hydroxide, boron, pH, total suspended solids (TSS), and, oil and grease.

NMFS has no information on the actual levels of these pollutants discharged in the past. NMFS assumes, for the purposes of this analysis, that discharges from Indian Point will be in compliance with the pollutant limits included in the 1987 SPDES permit. The effect of discharges in compliance with these limits on shortnose sturgeon is discussed below.

7.2.3.1 Total Residual Chlorine

TRC is limited at a maximum daily average of 0.2mg/l. This level of chlorine is measured in the plant, prior to dilution in the Hudson River. Once the waste stream mixes with the Hudson River, concentrations of TRC will be a maximum of 0.019 mg/l (for one hour) and 0.011mg/l (indefinitely).

To date, the effects of TRC on shortnose sturgeon have not been studied; however, there have been a number of studies that have examined the effects of levels of TRC on various fish species (Post 1987; Buckley 1976), including a recent study done on the white sturgeon (Campbell and Davidson 2007). Campbell and Davidson (2007) found that at concentrations of 0.034-0.042 mg/l of chlorine over four days, 50% of the test population, which consisted of 30 day old and 160 day old early life stage and juvenile sturgeon, died (i.e., 96 hour LC50). Similarly, adverse effects to rainbow trout (e.g., reductions of hemoglobin and hemocrit levels indicative of anemia) were found to occur at TRC levels of approximately 0.03 -0.04 mg/L (Buckley 1976; Black and McCarthy 1990). In a study conducted by Dwyer et al. (2000a), researchers compared toxicity test results for a range of species tested, including shortnose and Atlantic sturgeon. While TRC was not one of the compounds tested, the authors concluded that toxicity test results for rainbow trout were a good surrogate for effects to listed fish species, including shortnose sturgeon. As such, while recognizing that these conclusions are based on a limited number of chemical exposures, if rainbow trout can be considered a reasonable surrogate for toxicity testing for shortnose and Atlantic sturgeon, and TRC levels of 0.03-0.04mg/l have been shown to cause adverse affects to rainbow trout, it is reasonable to conclude that shortnose sturgeon would also experience adverse effects if exposed to TRC levels of 0.03-0.04mg/l. The concentration of TRC authorized by the SPDES permit (0.011mg/l in the river) is below the levels shown to adversely affect fish. As such, NMFS anticipates that any effects to shortnose and Atlantic sturgeon from exposure to TRC at concentrations authorized by the SPDES permit would be insignificant and discountable.

7.2.3.2 Lithium hydroxide

The 1987 SPDES permit authorizes the discharge of lithium hydroxide at a daily maximum concentration of 0.01mg/l. Limited information is available on the toxicity of lithium hydroxide to aquatic species. The no effect concentration level for fish is reported at 13mg/l as determined by exposure of fathead minnows; no effect concentration levels for Daphnia magna are reported at 11mg/l (Long et al. 1997). While no studies have examined the effects of lithium exposure to shortnose sturgeon, as the levels of lithium authorized by the SPDES permit are lower than the levels shown to have no effects to fathead minnows, which are typically used as a surrogate species for other fish in toxicity testing, we anticipate that any effects to shortnose or Atlantic sturgeon from exposure to boron at concentrations authorized by the SPDES permit would be insignificant and discountable.

7.2.3.3 Boron

The 1987 SPDES permit authorizes the discharge of boron at monthly average concentrations of 1.0mg/l. Chronic toxicity studies with *Daphnia magna* indicate no effect concentration (NOEC) levels ranging between 6 and 10 mg boron/litre (IPCS 1998). A 28-day laboratory study consisting of six trophic stages yielded a NOEC of 2.5 mg boron/litre. Acute tests with several fish species yielded toxicity values ranging from about 10 to nearly 300 mg boron/litre. Rainbow trout (*Oncorhynchus mykiss*) and zebra fish (*Brachydanio rerio*) were the most sensitive, providing values around 10 mg boron/liter (IPCS 1998). While no studies have examined the effects of boron exposure to shortnose or Atlantic sturgeon, as the levels of boron authorized by the SPDES permit are lower than the levels shown to have no effects to a variety of fish species, we anticipate that any effects to shortnose and Atlantic sturgeon from exposure to boron at concentrations authorized by the SPDES permit would be insignificant and discountable.

7.2.3.4 pH

The permit requires that the discharge maintain a pH of 6.0 – 9.0. This pH is within the normal range of pH for river water. As such, any change in the pH of the receiving water due to the discharge from Indian Point is not expected to deviate significantly from the receiving waters pH and will remain within the normal range for river water that is known to be harmless to aquatic life. Therefore, any effects to shortnose and Atlantic sturgeon will be discountable.

7.2.3.5 Total Suspended Solids

The 1987 SPDES permit limits the discharge of TSS to a daily maximum of 50mg/l and a monthly average of 30mg/L. TSS can affect aquatic life directly by killing them or reducing growth rate or resistance to disease, by preventing the successful development of fish eggs and larvae, by modifying natural movements and migration, and by reducing the abundance of available food (EPA 1976). These effects are caused by TSS decreasing light penetration and by burial of the benthos. Eggs and larvae are most vulnerable to increases in solids. Due to the distance from the spawning site, neither shortnose or Atlantic sturgeon eggs or larvae are likely to occur in the vicinity of the discharge.

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993).

The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580mg/L to 700,000mg/L depending on species. Sublethal effects have been observed at substantially lower turbidity levels. For example, prey consumption was significantly lower for striped bass larvae tested at concentrations of 200 and 500 mg/L compared to larvae exposed to 0 and 75 mg/L (Breitburg 1988 in Burton 1993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993). While there have been no directed studies on the effects of TSS on shortnose or Atlantic sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water and Dadswell (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass. Given that Atlantic sturgeon occur in similar habitats to shortnose sturgeon, we expect Atlantic sturgeon to have similar tolerances to suspended sediments and turbidity as shortnose sturgeon.

No adverse effects to juvenile or adult fish have been documented at levels at or below 50mg/L (above the highest level authorized by this permit). Based on this information, it is likely that the discharge of TSS in the concentrations authorized by the permit will have an insignificant effect on shortnose and Atlantic sturgeon.

7.2.3.6 Oil and Grease

High concentrations of petroleum products such as oil and grease can be toxic to aquatic life, including shortnose sturgeon. EPA (1976) indicates that lethal levels of gasoline for finfish are 91mg/L and for waste oil are 1700mg/L. No information is available on the toxic levels of petroleum products on shortnose sturgeon specifically. The limits in the SPDES permit (15mg/L monthly average) is well below the limits demonstrated to cause effects to fish. In addition, as the permit prohibits the discharge of levels of oil and grease at levels that are visible, levels are not likely to reach those where there is a risk of coating. As such, the effect of any exposure of shortnose and Atlantic sturgeon to oil and grease discharged at levels in compliance with the SPDES permit will be insignificant and discountable.

7.2.3.7 Other Criteria and Requirements of the SPDES Permit

The permit also contains criteria for the thermal plume. Effects of the thermal discharge are considered above. The 1987 SPDES permit also directs Entergy to comply with the biological sampling requirements of the HRSA. These include sampling surveys conducted throughout the Hudson River. These surveys result in the capture of shortnose and Atlantic sturgeon; however, capture and handling of shortnose and Atlantic sturgeon during these studies is authorized by NMFS through the ESA Section 10 scientific research permit discussed above (currently permit #17095, available at: https://apps.nmfs.noaa.gov/preview/applicationpreview.cfm?ProjectID=17095&view=01000000000000). The permit authorizes the take of 82 shortnose sturgeon and 82 Atlantic sturgeon annually. These fish will be captured in trawls and will be tagged (PIT and dart), measured, weighed and have tissue samples taken. The permit also authorizes the lethal collection of 40 shortnose sturgeon eggs/larvae and 40 Atlantic sturgeon eggs/larvae annually. These early life stages will be collected during ichthyoplankton sampling. The permit is valid from January 20, 2012 until August 28, 2017. All sturgeon captured during the trawl surveys are expected to be returned to the river alive. No lethal or sublethal effects of trawling are anticipated. The only lethal take authorized by the Section 10 permit is for the 40 eggs or larvae captured during ichthyoplankton sampling. The ESA Section 7 consultation completed on the issuance of this permit determined that the action was not likely to jeopardize the continued existence of shortnose sturgeon or any DPS of Atlantic sturgeon (available at: http://www.nmfs.noaa.gov/pr/consultation/opinions.htm). Because effects to listed species from these studies have already been considered, these studies will not be considered further in this Opinion.

7.3 Non-Routine and Accidental Events

By their nature, non-routine and accidental events that may affect the marine environment are unpredictable and typically unexpected. In the FSEIS, NRC considers design-basis accidents (DBAs); these are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. NRC states that "a number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility" (NRC FSEIS 2011). NRC states that the environmental impacts of these DBAs will be "small" (i.e., insignificant), because the plant is designed to withstand these types of accidents including during the extended operating period.

NRC also states that the risk of severe accidents initiated by internal events, natural disasters or terrorist events is small. As noted by Thompson (2006) in a report regarding the risks of spent-fuel pool storage at nuclear power plants in the U.S., the available information does not allow a statistically valid estimate of the probability of an attack-induced spent-fuel-pool fire. However, Thompson states that "prudent judgment" indicates that a probability of at least one per century within the U.S. is a reasonable assumption. There have been very few instances of accidents or natural disasters that have affected nuclear facilities and none at IP2 or IP3 that have led to any impacts to the Hudson River. While the experience at Fukishima in Japan provides evidence that natural disaster induced problems at nuclear facilities can be severe and may have significant consequences to the environment, the risk of non-routine and accidental events at Indian Point that would affect the riverine environment, and subsequently affect shortnose and Atlantic sturgeon, is extremely low. Because of this, effects to listed species are discountable. We expect that in the unlikely event of any accident or disaster that affects the riverine environment, reinitiation of consultation, or an emergency consultation, would be necessary.

7.4 Effects of Operation in light of Anticipated Future Climate Change

In the future, global climate change is expected to continue and may impact listed species and their habitat in the action area. The period considered for the continued operation of IP2 is now through 2033 and for IP3 is now through 2035.

In section 6.0 above we considered effects of global climate change on shortnose and Atlantic sturgeon. It is possible that there will be effects to sturgeon from climate change over the time that IP2 and IP3 continue to operate. As explained above, based on currently available information and predicted habitat changes, these effects are most likely to be changes in distribution and timing of seasonal migrations of sturgeon throughout the Hudson River including the action area. However, because we expect only a small increase in water temperature (1°C) and a small change in the location of the salt wedge (shifting further upstream from the action area), there are not likely to be major shifts in abundance, distribution or seasonal use of the action area by Atlantic sturgeon or shortnose sturgeon.

The greatest potential for climate change to impact our assessment would be if (1) ambient water temperatures increased enough such that a larger portion of the thermal plume had temperatures that were stressful for listed species or their prey or if (2) the status, distribution and abundance of listed species or their prey changed significantly in the action area. Given the small predicted increase in ambient water temperatures in the action area during the time period considered (1°C), it is not likely that over the remainder of the operating period that any water temperature changes would be significant enough to affect the conclusions reached by us in this consultation. If new information on the effects of climate change becomes available then reinitiation of this consultation may be necessary.

8.0 CUMULATIVE EFFECTS

Cumulative effects, as defined in 50 CFR 402.02, are those effects of future State or private activities, not involving Federal activities, which are reasonably certain to occur within the action area. Future Federal actions are not considered in the definition of "cumulative effects." It is important to note that the definition of "cumulative effects" in the section 7 regulations is not the same as the NEPA definition of cumulative effects. However, the factors discussed in the Cumulative Effects section of NRC's FSEIS - continued withdrawal of water to support fossil fuel electrical generation or water for human use; the presence of invasive or nuisance species; fishing pressure; habitat loss; changes to water and sediment quality; and, climate change are largely consistent with the cumulative effects we consider here.

Activities reasonably certain to occur in the action area and that are carried out or regulated by the State of New York and that may affect shortnose and Atlantic sturgeon include the authorization of state fisheries and the regulation of point and non-point source pollution through the National Pollutant Discharge Elimination System. We are not aware of any local or private actions that are reasonably certain to occur in the action area that may affect listed species.

While there may be other in-water construction or coastal development within the action area, all of these activities are likely to need a permit or authorization from the US Army Corps of Engineers and would therefore, be subject to section 7 consultation.

State Water Fisheries - Future recreational and commercial fishing activities in state waters may take shortnose and Atlantic sturgeon. In the past, it was estimated that up to 100 shortnose sturgeon were captured in shad fisheries in the Hudson River each year, with an unknown mortality rate. Atlantic sturgeon were also incidentally captured in NY state shad fisheries. In 2009, NY State closed the shad fishery indefinitely. That state action is considered to benefit both sturgeon species. Should the shad fishery reopen, shortnose and Atlantic sturgeon would be exposed to the risk of interactions with this fishery. However, NMFS has no indication that reopening the fishery is reasonably certain to occur.

Information on interactions with shortnose and Atlantic sturgeon for other fisheries operating in the action area is not available, and it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Status of the Species/Environmental Baseline section. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the status of the species/environmental baseline section.

State PDES Permits – The State of New York has been delegated authority to issue NPDES permits by the EPA. These permits authorize the discharge of pollutants in the action area. Some of the facilities that operate pursuant to these permits are included in the Environmental Baseline. Other permitees include municipalities for sewage treatment plants and other industrial users. The states will continue to authorize the discharge of pollutants through the SPDES permits. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the status of the species/environmental baseline section.

9.0 INTEGRATION AND SYNTHESIS OF EFFECTS

We have estimated that the continued operation of IP2 with continued withdrawal of water through the IP1 intake, pursuant to the existing operating license and through the proposed extended license period (now through September 28, 2033) will result in the impingement and mortality of 395 shortnose sturgeon and 269 juvenile New York Bight DPS Atlantic sturgeon at the Ristroph screens. The continued operation of IP3, pursuant to the existing operating license and through the proposed extended license period (now through December 12, 2035), will result in the impingement and mortality of 167 shortnose sturgeon and 145 juvenile New York Bight DPS Atlantic sturgeon at that IP3 Ristroph screens. An additional number of dead or stressed adult shortnose sturgeon and dead or stressed subadult or adult New York Bight, Chesapeake Bay and Gulf of Maine DPS Atlantic sturgeon will be impinged at the IP1, IP2 and IP3 trash bars. However, the cause of death/stressor of sturgeon impinged at the trash bars is currently unknown. As explained in the "Effects of the Action" section, all other effects to shortnose sturgeon and New York Bight, Chesapeake Bay and Gulf of Maine DPS Atlantic sturgeon, including to their prey and from the discharge of heat, will be insignificant or discountable. No entrainment of shortnose or Atlantic sturgeon is anticipated.

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of any listed species. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Below, for the listed species that may be affected by the proposed action, NMFS summarizes the status of the species and considers whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of that species, as those terms are defined for purposes of the federal Endangered Species Act.

9.1 Shortnose Sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

The Hudson River population of shortnose sturgeon is the largest in the United States. Historical estimates of the size of the population are not available as historic records of sturgeon in the river did not discriminate between Atlantic and shortnose sturgeon. Population estimates made by Dovel et al. (1992) based on studies from 1975-1980 indicated a population of 13,844 adults. Bain et al. (1998) studied shortnose sturgeon in the river from 1993-1997 and calculated an adult population size of 56,708 with a 95% confidence interval ranging from 50,862 to 64,072 adults. Bain determined that based on sampling effort and methodology his estimate is directly comparable to the population estimate made by Dovel et al. Bain concludes that the population of shortnose sturgeon in the Hudson River in the 1990s was 4 times larger than in the late 1970s. Bain states that as his estimate is directly comparable to the estimate made by Dovel, this increase is a "confident measure of the change in population size." Bain concludes that the Hudson River population is large, healthy and particular in habitat use and migratory behavior. Woodland and Secor (2007) conducted studies to determine the cause of the increase in population size. Woodland and Secor captured 554 shortnose sturgeon in the Hudson River and made age estimates of these fish. They then hindcast year class strengths and corrected for gear selectivity and cumulative mortality. The results of this study indicated that there was a period of high recruitment (31,000 – 52,000 yearlings) in the period 1986-1992 which was preceded and succeeded by 5 years of lower recruitment (6,000 – 17,500 yearlings/year). Woodland and Secor reports that there was a 10-fold recruitment variability (as measured by the number of yearlings produced) over the 20-year period from the late 1970s to late 1990s and that this pattern is expected in a species, such as shortnose sturgeon, with periodic life history characterized by delayed maturation, high fecundity and iteroparous spawning, as well as when there is variability in interannual hydrological conditions. Woodland and Secor examined environmental conditions throughout this 20-year period and determined that years in which water temperatures drop quickly in the fall and flow increases rapidly in the fall (particularly October), are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults.

The Hudson River population of shortnose sturgeon has exhibited tremendous growth in the 20-year period between the late 1970s and late 1990s. Woodland and Secor conclude that this is a robust population with no gaps in age structure. Lower recruitment that followed the 1986-1992 period is coincident with record high abundance suggesting that the population may be reaching carrying capacity. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, add uncertainty to any determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is at best stable, with gains in populations such as the Hudson, Delaware and Kennebec offsetting the continued decline of southern river populations, and at worst declining.

As described in the Status of the Species/Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the action area are affected by impingement at water intakes, habitat alteration, bycatch in commercial and recreational fisheries, water quality and in-water construction activities. It is difficult to quantify the number of shortnose sturgeon that may be killed in the Hudson River each year due to anthropogenic sources. Through reporting requirements implemented under Section 7 and Section 10 of the ESA, for specific actions NMFS obtains some information on the number of incidental and directed takes of shortnose sturgeon each year. Typically, scientific research results in the capture and collection of less than 100 shortnose sturgeon in the Hudson River each year, with little if any mortality. NMFS has no reports of interactions or mortalities of shortnose sturgeon in the Hudson River resulting from dredging or other in-water construction activities. NMFS also has no quantifiable information on the effects of habitat alteration or water quality; in general, water quality has improved in the Hudson River since the 1970s when the CWA was implemented. NMFS also has anecdotal evidence that shortnose sturgeon are expanding their range in the Hudson River and fully utilizing the river from the Manhattan area upstream to the Troy Dam, which suggests that the movement and distribution of shortnose sturgeon in the river is not limited by habitat or water quality impairments. Impingement at the Roseton and Danskammer plants is regularly reported to NMFS. Since reporting requirements were implemented in 2000, less than the exempted number of takes (6 total for the two facilities) have occurred each year. We also anticipate the mortality of two shortnose sturgeon over the next five years as a result of impacts of the replacement of the Tappan Zee Bridge. Despite these ongoing threats, there is evidence that the Hudson River population of shortnose sturgeon experienced tremendous growth between the 1970s and 1990s and that the population is now stable at high numbers. Shortnose sturgeon in the Hudson River continue to experience anthropogenic and natural sources of mortality. However, NMFS is not aware of any future actions that are reasonably certain to occur that are individually or cumulatively likely to change this trend or reduce the stability of the Hudson River population. Also, as discussed above, NMFS does not expect shortnose sturgeon to experience any new effects associated with climate change during the 23-year duration of the proposed action. As such, NMFS expects that numbers of shortnose sturgeon in the action area will continue to be stable at high levels over the 23-year duration of the proposed action.

We have estimated that the proposed continued operation of IP2 through the duration of the existing operating license and the proposed extended operating license (i.e., through September 28, 2033) will result in the impingement of an average of 19 shortnose sturgeon per year at the Ristroph screens, for a total of 395 shortnose sturgeon impinged at the Ristroph screens, inclusive of the impingement of 2 shortnose sturgeon impinged at the IP1 Ristroph screens. The proposed continued operation of IP3 through the duration of the existing operating license and the proposed extended operating license (i.e., through December 12, 2035) will result in the impingement of an average of 7 shortnose sturgeon per year at the Ristroph screens, for a total of 167 shortnose sturgeon impinged at the Ristroph screens. Based on the available information, we are not able to determine what portion of these shortnose sturgeon impinged at the Ristroph screens will be alive, injured or previously killed, or die as a result of their impingement. Because we know that there will be impingement mortality (available monitoring results suggest at least an 80% mortality rate for shortnose sturgeon), but are not able to accurately predict the mortality rate, we have made the conservative assumption that all shortnose sturgeon impinged at the Ristroph screens will be mortally injured or killed. Therefore, we expect that over the 23 year period, up to 562 shortnose sturgeon will be killed as a result of impingement at the Indian Point Ristroph screens (395 as a result of the operations of IP2 and 167 as a result of the operations of IP3). We expect the amount of impingement to vary annually; however, the conclusions reached in the Opinion are based on it taking 21 years to reach the total impingement level for IP2 (inclusive of IP1 intakes) and 23 years to reach the total impingement level for IP3. In any given year, we do not expect impingement of shortnose sturgeon to be higher than 71 individuals per year at the IP2 Ristroph screens or higher than 32 individuals per year at the IP3 Ristroph screens. We also do not expect impingement levels to be higher than 50 shortnose sturgeon for more than two consecutive years at IP2 or higher than 26 shortnose sturgeon for more than two consecutive years at IP3.

We expect an additional number of adult shortnose sturgeon (body widths greater than 3”) will be impinged on the trash bars in front of the IP1, IP2 and IP3 intakes. Because of the size of these fish and the low velocity at the trash bars (0.6-1.0 fps) and because sturgeon would need to get stuck on the racks in order to be impinged (as opposed to the Ristroph screens where free swimming fish could be captured by the traveling buckets), and fish of this size should be able to readily avoid impingement at these velocities, all shortnose sturgeon impinged at the trash bars are expected to be dead or stressed in a way that decreases their normal swimming ability. Based on the current lack of available information, the cause of death/stressor is currently unknown. The operation of Indian Point will cause the impingement and the “capture” or “collection” of these fish given the presence of the trash bars, the flow of water through them into the facilities’ service and cooling water systems, and the simple facts that some fish will be too big to fit through the bars and incapable of avoiding the trash bars. The capture and collection of fish killed prior to impingement would not affect the numbers, reproduction or distribution of shortnose sturgeon in the Hudson River or throughout their range.

The number of shortnose sturgeon we expect to be killed due to the operations of the two Indian Point facilities (562 over 23 years) represents a very small percentage of the shortnose sturgeon population in the Hudson River, which is believed to be stable at high numbers, and an even smaller percentage of the total population of shortnose sturgeon rangewide. The best available population estimates indicate that there are approximately 56,708 (95% CI=50,862 to 64,072) adult shortnose sturgeon in the Hudson River and an unknown number of juveniles (Bain 2000). While the death of up to 562 shortnose sturgeon over the next 23 years will reduce the number of shortnose sturgeon in the population compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population or its stable trend. This is because this loss represents a very small percentage of the population (less than 1.0%, just considering the number of adults). The impact of this loss is even less when considered on an annual basis. Based on the available monitoring data (1974-1990), we expect the number of shortnose sturgeon impinged at the Ristroph screens will be variable. Adjusting the past annual impingement numbers for the increased population size and the increased water usage, we would predict that the number of shortnose sturgeon impinged at the Ristroph screens each year would range from 0 to 71 for IP2 and 0-32 for IP3. However, we expect the annual average to be 19 shortnose sturgeon at IP2 and 6 at IP3 and do not expect impingement of more than 50 shortnose sturgeon at IP2 or 26 at IP3 to occur in more than two consecutive years. The average annual loss of 26 shortnose sturgeon represents approximately 0.05% of the Hudson River shortnose sturgeon population; even the worst predicted annual loss of 103 shortnose sturgeon (the maximum annual loss at IP2 plus the maximum annual loss at IP3) represents only 0.18% of the population. Additionally, it is important to note that this is not a new source of mortality. The Hudson River population has exhibited tremendous growth during the period of time that IP2 and IP3 have been operational; we do not expect the rate of impingement to change in the future, therefore, it is reasonable to expect that the continued operation of IP2 and IP3 would not preclude maintenance of the population's stable trend.

Reproductive potential of the Hudson population is not expected to be affected in any other way other than through a reduction in numbers of individuals. A reduction in the number of shortnose sturgeon in the Hudson River would have the effect of reducing the amount of potential reproduction in this system as the fish killed would have no potential for future reproduction. However, it is estimated that on average, approximately 1/3 of adult females spawn in a particular year and approximately ½ of males spawn in a particular year. Given that the best available estimates indicate that there are more than 56,000 adult shortnose sturgeon in the Hudson River, it is reasonable to expect that there are at least 20,000 adults spawning in a particular year. Because fish with body widths greater than 3" would be excluded from the Ristroph screens by the trash racks, we expect that the only shortnose sturgeon that would be impinged at the Ristroph screens and die would be juveniles. While this will result in fewer spawning adults in the future, it is unlikely that the loss of an average of 26 juvenile shortnose sturgeon per year over a 23-year period would affect the success of spawning in any year. Additionally, this small reduction in potential spawners is expected to result in a small reduction in the number of eggs laid or larvae produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individuals that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be very small and would not change the stable trend of this population. Additionally, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds and will not result in the death of spawning adults.

The proposed action is not likely to reduce distribution because the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Hudson River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Additionally, as the number of shortnose sturgeon likely to be killed (562) as a result of the proposed action is less than 1.0% of the Hudson River population, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species can have an appreciable effect on the likelihood of survival and recovery of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity (see status of the species/environmental baseline section above), and there are thousands of shortnose sturgeon spawning each year.

Based on the information provided above, the death of up to 562 shortnose sturgeon over a 23-year period (i.e., from now through December 12, 2035) resulting from the proposed continued operation of IP2 and IP3 will not appreciably reduce the likelihood of survival of this species (i.e., the likelihood that the species will continue to exist in the future while retaining the potential for recovery) because, (1) it will not cause so many mortalities that the population will decrease; (2) the population trend of shortnose sturgeon in the Hudson River is stable at high levels; (3) the death of an average of 26 shortnose sturgeon per year represents an extremely small percentage of the number of shortnose sturgeon in the Hudson River and an even smaller percentage of the species as a whole; (4) the loss of these shortnose sturgeon is likely to have such a small effect on reproductive output of the Hudson River population of shortnose sturgeon or the species as a whole that the loss of these shortnose sturgeon will not change the status or trends of the Hudson River population or the species as a whole; and, (5) the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area (related to movements around the thermal plume) and no effect on the distribution of the species throughout its range.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that shortnose sturgeon can rebuild to a point where shortnose sturgeon are no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for shortnose sturgeon was published in 1998 pursuant to Section 4(f) of the ESA. The Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely. However, the plan states that the minimum population size for each population has not yet been determined. The Recovery Outline contains three major tasks, (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the Hudson River population of shortnose sturgeon in a way that would affect the species likelihood of recovery.

The Hudson River population of shortnose sturgeon has experienced an increasing trend and is currently stable at high levels. This action will not change the status or trend of the Hudson River population of shortnose sturgeon or the species as a whole. This is because the reduction in numbers will be small and the impact on reproduction and future year classes will also be small enough not to affect the stable trend of the population. The proposed action will have only insignificant effects on habitat and forage and will not impact the river in a way that makes additional growth of the population less likely, that is, it will not reduce the river's carrying capacity. This is because impacts to forage will be insignificant and discountable, and the area of the river that sturgeon will be precluded from (due to high temperatures) is small. The proposed action will not affect shortnose sturgeon outside of the Hudson River. Therefore, because it will not reduce the likelihood that the Hudson River population can recover, it will not reduce the likelihood that the species as a whole can recover. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

9.2 Atlantic sturgeon

As explained above, the proposed continued operation of IP2 is likely to result in the impingement of 269 juvenile New York Bight DPS Atlantic sturgeon at the Ristroph screens between now and September 28, 2033, inclusive of 2 Atlantic sturgeon impinged at the IP1 Ristroph screens, at an average rate of 13 Atlantic sturgeon per year. We anticipate the continued operation of IP3 will result in the impingement of 145 juvenile New York Bight DPS Atlantic sturgeon at the Ristroph screens between now and December 12, 2035, at an average rate of 6 per year. We expect that an additional number of subadult and adult Atlantic sturgeon (body widths greater than 3”) will be impinged on the trash bars in front of the IP1, IP2 and IP3 intakes. Because of the size of these fish and the low velocity at the trash bars (0.6-1.0 fps) and because sturgeon would need to get stuck on the racks in order to be impinged (as opposed to the Ristroph screens where free swimming fish could be captured by the traveling buckets), and fish of this size should be able to readily avoid impingement at these velocities, all Atlantic sturgeon impinged at the trash bars are expected to be dead or stressed and the cause of death/stressor is currently unknown. The operation of Indian Point would, however, cause the impingement and the “capture” or “collection” of these previously killed fish; based on mixed stock analysis, we expect the individuals impinged on the trash bars to originate from the Gulf of Maine, New York Bight and Chesapeake Bay DPSs. Individual Atlantic sturgeon from the Gulf of Maine, New York Bight and Chesapeake Bay DPSs would be exposed to effects of the action including the thermal plume, other pollutants and impacts to prey and habitats. Based on the best available information, we do not expect that individuals from the Carolina or South Atlantic DPS will occur in the action area.

9.2.1 New York Bight DPS of Atlantic sturgeon

The NYB DPS has been listed as endangered. While Atlantic sturgeon occur in several rivers in the NYB DPS, recent spawning has only been documented in the Delaware and Hudson rivers. As noted above, we expect all Atlantic sturgeon impinged at the Indian Point Ristroph screens will originate from the Hudson River. There is limited information on the demographics of the Hudson River population of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007).

No data on abundance of juveniles are available prior to the 1970s; however, catch depletion analysis estimated conservatively that 6,000-6,800 females contributed to the spawning stock during the late 1800s (Secor 2002, Kahnle *et al*. 2005). Two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately 6 year classes, excluding young of year.

In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and 14 wild age-1 Atlantic sturgeon (Peterson *et al*. 2000). A Petersen mark-recapture population estimate from these data suggests that there were 9,529 (95% CI = 1,916 – 10,473) age-0 Atlantic sturgeon in the estuary in 1994. Since 4,929 were stocked, 4,600 fish were of wild origin, assuming equal survival for both hatchery and wild fish and that stocking mortality for hatchery fish was zero.

Information on trends for Atlantic sturgeon in the Hudson River are available from a number of long term surveys. From July to November during 1982-1990 and 1993, the NYSDEC sampled the abundance of juvenile fish in Haverstraw Bay and the Tappan Zee Bay. The CPUE of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since this time.

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which are collected from May-July, provide an annual index of juvenile Atlantic sturgeon in the Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July – October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early 1990s. While the amount of interannual variability makes it difficult to detect short term trends, a five year running average of CPUE from the FJS indicates a slowly increasing trend since about 1996. Interestingly, that is when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003 – 2005, 579 juveniles were collected (N = 122, 208, and 289, respectively) (Sweka et al. 2006). Pectoral spine analysis showed they ranged from 1 – 8 years of age, with the majority being ages 2 – 6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles.

NYB DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. A bycatch estimate provided by NEFSC indicates that approximately 376 Atlantic sturgeon die as a result of bycatch each year. Mixed stock analysis from the NMFS NEFOP indicates that 49% of these individuals are likely to originate from the NYB and 91% of those likely originate from the Hudson River, for a total of approximately 167 adult and subadult mortalities annually. Because juveniles do not leave the river, they are not impacted by fisheries occurring in Federal waters. Bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (shad), has now been closed and there is no indication that it will reopen soon. NYB DPS Atlantic sturgeon are killed as a result of anthropogenic activities in the Hudson River and other rivers; sources of potential mortality include vessel strikes and entrainment in dredges. As noted above, we expect the mortality of two Atlantic sturgeon as a result of the Tappan Zee Bridge replacement project; it is possible that these individuals could originate from the Hudson River. There could also be the loss of a small number of juveniles at other water intakes in the River including the Danskammer and Roseton plants.

The Atlantic sturgeon that will be killed at Indian Point are expected to be juveniles that originate from Hudson River. The most recent estimate of juveniles was 4,600 wild Hudson River juveniles in the 1994 year class. While we have no estimates of the number of juveniles since that time, the available information on trends indicates that there may be a slight increasing trend in juvenile abundance in the Hudson River since the mid-1990s. This suggests that there may be more juveniles in the river now than in 1994. Based on the size of fish impinged in the past, Atlantic sturgeon impinged at IP2 and IP3 are likely to be less than three years old. Even assuming that the three youngest year classes in the Hudson River only have 4,600 individuals each, we would estimate that there are at least 13,800 juvenile Atlantic sturgeon in the Hudson River. We are anticipating a loss of approximately 19 juvenile Atlantic sturgeon per year for 23 years. While there are likely other sources of mortality for juvenile Atlantic sturgeon in the Hudson River, there appears to be a recent increasing trend of juveniles in the river, as evidenced by the upward trend in the 5-year moving average for the FJS CPUE. The closure of the directed Atlantic sturgeon fishery in 1996 and the shad fishery in 2010 are expected to have led to reduced bycatch of juvenile Atlantic sturgeon and subsequently may contribute to increased survival of young sturgeon. It is also important to note that the mortality we are considering here is not a new source of mortality. Any increase in the juvenile population has occurred with the ongoing impingement of individuals at IP2 and IP3.

The proposed continued operation of IP2 is likely to result in the impingement of 269 juvenile New York Bight DPS Atlantic sturgeon at the Ristroph screens between now and September 28, 2033, inclusive of 2 Atlantic sturgeon impinged at the IP1 Ristroph screens, at an average rate of 13 Atlantic sturgeon per year. We anticipate the continued operation of IP3 will result in the impingement of 145 juvenile New York Bight DPS Atlantic sturgeon at the Ristroph screens between now and December 12, 2035, at an average rate of 6 per year. In total, we expect the continued operation of IP2 and IP3 to result in the impingement of 414 NYB DPS Atlantic sturgeon at the IP1, IP2 and IP3 Ristroph screens. Based on the available information, we are not able to determine what portion of these Atlantic sturgeon impinged at the Ristroph screens will be alive, injured, previously killed, or will die as a result of their impingement. Because we know that there will be impingement mortality (available monitoring results suggest at least an 60% mortality rate for Atlantic sturgeon), but are not able to accurately predict the mortality rate, we have made the conservative assumption that all Atlantic sturgeon impinged at the Ristroph screens will be mortally injured or killed. Therefore, we expect that over the 23 year period, up to 414 NYB DPS Atlantic sturgeon will be killed as a result of impingement at the Indian Point Ristroph screens (2 at IP1, 267 at IP2 and 145 at IP3). We expect the amount of impingement to vary annually; however, the conclusions reached in the Opinion are based on it taking 21 years to reach the total impingement level for IP2 (inclusive of IP1 intakes) and 23 years to reach the total impingement level for IP3. In any given year, we do not expect impingement of NYB DPS Atlantic sturgeon to be higher than 31 individuals per year at the IP2 Ristroph screens or higher than 40 individuals per year at the IP3 Ristroph screens. We also do not expect impingement levels to be higher than 10 NYB DPS Atlantic sturgeon for more than two consecutive years at IP2 or higher than 10 NYB DPS Atlantic sturgeon for more than two consecutive years at IP3.

Wwe expect an additional number of subadult and adult Atlantic sturgeon (body widths greater than 3”) will be impinged on the trash bars in front of the IP1, IP2 and IP3 intakes. Because of the size of these fish and the low velocity at the trash bars (0.6-1.0 fps) and because sturgeon would need to get stuck on the racks in order to be impinged (as opposed to the Ristroph screens where free swimming fish could be captured by the traveling buckets), and healthy fish of this size should be able to readily avoid impingement at these velocities, all shortnose sturgeon impinged at the trash bars are expected to be dead or stressed. Based on currently available information, the cause of death/stressor is currently unknown. The operation of Indian Point will cause the impingement and the “capture” or “collection” of these fish. The capture and collection of NYB DPS subadults or adults killed prior to impingement would not affect the numbers, reproduction or distribution of the NYB DPS in the Hudson River or throughout their range.

The number of juvenile Atlantic sturgeon we expect to be killed due to the operation of Indian Point (414over 23 years) represents a small percentage of the Atlantic sturgeon population in the Hudson River. While the death of up to 414 juvenile Atlantic sturgeon over the next 23 years will reduce the number of NYB DPS Atlantic sturgeon compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this species as this loss represents a very small percentage of the Hudson River population of juveniles and an even smaller percentage of the overall Hudson River population or the DPS as a whole. The impact of this loss is even less when considered on an annual basis. Based on the available monitoring data (1974-1990), we expect the number of Atlantic sturgeon impinged at the Ristroph screens will be variable each year. Adjusting the past annual impingement numbers for the 1985-1990 period to account for the increased water usage, we would predict that the number of Atlantic sturgeon impinged at the Ristroph screens each year would range from 0 to 71. However, we expect the annual average to be 19 Atlantic sturgeon and do not expect impingement of more than 10 Atlantic sturgeon at either IP2 or IP3 to occur in more than two consecutive years. The average annual loss of 19 juvenile Atlantic sturgeon from the NYB DPS represents a very small percentage of our minimum estimated juvenile population (13,800 see above); the loss of an average of 19 Atlantic sturgeon per year is approximately 0.14% of the estimated Hudson River origin juvenile population (ages 1-3). The percentage would be much less if we also considered the number of adults, subadults and young of year as well as any Delaware River origin sturgeon. Even considering a year when 71 individuals are impinged at the Ristroph screens (the highest level of annual impingement that we expect will occur), this would represent approximately 0.5% of the Hudson River origin juveniles. It is important to note that we expect the loss of 414 individuals to occur over the 23 period, we do not expect the loss of more than 19 individuals for two consecutive years and never anticipate the loss of more than 71 individuals in any one year.

Because there will be no loss of adults, the reproductive potential of the NYB DPS will not be affected in any way other than through a reduction in numbers of individual future spawners as opposed to current spawners. The loss of an average of 19 juveniles per year for 23 years would have the effect of reducing the amount of potential reproduction as any dead NYB DPS Atlantic sturgeon would have no potential for future reproduction. This small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individuals that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed action will also not affect the spawning grounds within the Hudson River or Delaware River where NYB DPS fish spawn. We do not anticipate the impingement of any spawning adults. All effects to spawning adults will be insignificant and discountable and there will be no reduction in individual fitness or any future reduction in spawning by these individuals.

The proposed action is not likely to reduce distribution because the action will not impede NYB DPS Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Delaware or Hudson River or elsewhere. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area of the thermal plume.

Based on the information provided above, the death of an average of 19 juvenile NYB DPS Atlantic sturgeon annually for 23 years, will not appreciably reduce the likelihood of survival of the New York Bight DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect NYB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. This is the case because: (1) the death of these juvenile NYB DPS Atlantic sturgeon represents an extremely small percentage of the species; (2) the death of these juvenile NYB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these NYB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these juvenile NYB DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the action will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the action will have no effect on the ability of NYB DPS Atlantic sturgeon to shelter and only an insignificant effect on individual foraging NYB DPS Atlantic sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that shortnose sturgeon can rebuild to a point where the NYB DPS of Atlantic sturgeon is no longer in danger or extinction through all or a significant part of its range.

No Recovery Plan for the NYB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the Hudson River population of Atlantic sturgeon in a way that would affect the NYB DPS likelihood of recovery.

This action will not change the status or trend of the Hudson River population of Atlantic sturgeon or the status and trend of the NYB DPS as a whole. The proposed action will result in a small amount of mortality (an average of 19 juveniles annually from a population of at least 4,600 juveniles and likely at least 24,000 juveniles, just considering the Hudson River and not the DPS as a whole) and a subsequent small reduction in future reproductive output. This reduction in numbers will be small and the impact on reproduction and future year classes will also be small enough not to affect the stable trend of the population. The proposed action will have only insignificant effects on habitat and forage and will not impact the river in a way that makes additional growth of the population less likely, that is, it will not reduce the river's carrying capacity. This is because impacts to forage will be insignificant and discountable and the area of the river that sturgeon will be precluded from (due to high temperatures) is small. The proposed action will not affect Atlantic sturgeon outside of the Hudson River or affect habitats outside of the Hudson River. Therefore, it will not affect estuarine or oceanic habitats that are important for sturgeon. Because it will not reduce the likelihood that the Hudson River population can recover, it will not reduce the likelihood that the NYB DPS as a whole can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

9.2.2 Gulf of Maine DPS of Atlantic sturgeon

As explained above, the proposed action is likely to result in the impingement of adult and subadult Atlantic sturgeon at the trash bars. As explained in the Effects of the Action, we are not able to estimate the number of Atlantic sturgeon impinged at the trash bars. Based on mixed stock analysis of Atlatnic sturgeon captured in the Hudson River, we expect 6% of the adult and subadult Atlantic sturgeon in the action area to be GOM DPS origin. Therefore, we also expect 6% of the subadult and adult Atlantic sturgeon impinged at the IP trash racks to be GOM DPS origin. As noted above, because of the size of these fish and the low velocity at the trash bars (0.6-1.0 fps) and because sturgeon would need to get stuck on the racks in order to be impinged (as opposed to the Ristroph screens where free swimming fish could be captured by the traveling buckets), and fish of this size should be able to readily avoid impingement at these velocities, all Atlantic sturgeon impinged at the trash bars are expected to be dead or stressed and the cause of death/stressor is currently unknown. The operation of Indian Point will cause the impingement and the "capture" or "collection" of these fish. The capture and collection of fish killed prior to impingement would not affect the numbers, reproduction or distribution of the GOM DPS of Atlantic sturgeon. Individual Atlantic sturgeon from the Gulf of Maine DPS would be exposed to effects of the action including the thermal plume, other pollutants and impacts to prey and habitats; however, these effects will be insignificant and discountable. Based on this analysis, the proposed action is not likely to jeopardize the continued existence of the Gulf of Maine DPS of Atlantic sturgeon.

9.2.3 Chesapeake Bay DPS of Atlantic sturgeon

As explained above, the proposed action is likely to result in the impingement of adult and subadult Atlantic sturgeon at the trash bars. As explained in the Effects of the Action, we are not able to estimate the number of Atlantic sturgeon impinged at the trash bars. Based on mixed stock analysis of Atlantic sturgeon captured in the Hudson River, we expect 2% of the adult and subadult Atlantic sturgeon in the action area to be Chesapeake Bay DPS origin. Therefore, we also expect 6% of the subadult and adult Atlantic sturgeon impinged at the IP trash racks to be Chesapeake Bay DPS origin. As noted above, because of the size of these fish and the low velocity at the trash bars (0.6-1.0 fps) and because sturgeon would need to get stuck on the racks in order to be impinged (as opposed to the Ristroph screens where free swimming fish could be captured by the traveling buckets), and fish of this size should be able to readily avoid impingement at these velocities, all Atlantic sturgeon impinged at the trash bars are expected to be dead or stressed and the cause of death/stressor is currently unknown. The operation of Indian Point will cause the impingement and the "capture" or "collection" of these fish. The capture and collection of fish killed prior to impingement would not affect the numbers, reproduction or distribution of the Chesapeake Bay DPS of Atlantic sturgeon. Individual Atlantic sturgeon from the Chesapeake Bay DPS would be exposed to effects of the action including the thermal plume, other pollutants and impacts to prey and habitats; however, these effects will be insignificant and discountable. Based on this analysis, the proposed action is not likely to jeopardize the continued existence of the Chesapeake Bay DPS of Atlantic sturgeon.

10.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the proposed action, interdependent and interrelated actions and the cumulative effects, it is NMFS' biological opinion that the continued operation of Indian Point Unit 2 is likely to adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon or the New York Bight, Gulf of Maine or Chesapeake Bay DPS of Atlantic sturgeon. It is also NMFS' biological opinion that the continued operation of Indian Point Unit 3 is likely to adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon or the New York Bight, Gulf of Maine or Chesapeake Bay DPS of Atlantic sturgeon. No critical habitat is designated in the action area; therefore, none will be affected by the proposed actions.

11.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, nonmigratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof." 16 U.S.C. 1532(8). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person "to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]" 16 U.S.C. 1538(g). A "person" is defined in part as any entity subject to the jurisdiction of the United States, including an individual, corporation, officer, employee, department or instrument of the Federal government (see 16 U.S.C. 1532(13)). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by NRC and the applicant, Entergy, for the exemption in section 7(o)(2) to apply. NRC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NRC (1) fails to assume and implement the terms and conditions consistent with its authority or (2) fails to require the applicant, Entergy, to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms, the protective coverage of section 7(o)(2) may lapse. The effects analysis and conclusions reached in this Opinion, and, therefore, the incidental take levels, are based on data collected between 1974 and 1990. While there are uncertainties in this data, as acknowledged in the Opinion, it is the best available and relying on it for the development of this Opinion was reasonable. The monitoring and reporting required by this ITS will serve in part as a check on our reliance on this data. If NRC or Entergy fail to implement the required terms and conditions or are otherwise not in compliance with the terms and conditions at any point during the period when IP2 or IP3 are operating under the existing operating licenses or the proposed renewed operating licenses, reinitiation of consultation will be necessary. Reinitiation would be necessary in that case to determine why noncompliance was occurring and whether any changes to the terms and conditions would promote better compliance. In order to monitor the impact of incidental take, NRC or the applicant must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

11.1 Amount or Extent of Take

This ITS serves two important functions: (1) it provides an exemption from the Section 9 prohibitions for any taking incidental to the proposed action that is in compliance with the terms and conditions; and (2) it provides the means to insure the action as it is carried out is not jeopardizing the continued existence of affected species by monitoring and reporting the progress of the action and its impact on the species such that consultation can be reinitiated if any of the criteria in 50 CFR 402.16 are met. This ITS applies to the remaining term of the existing operating licenses and any extended operating period through the expiration date of those licenses. As such, we anticipate that this amount of take will occur at IP2, from now through September 28, 2033 and at IP3 until December 12, 2035. Take will also occur at the IP1 intakes as long as they are used for service water for IP2 which will occur from now until the IP2 license expires on September 28, 2033. The continued operation of IP2 and IP3 will adversely affect shortnose and Atlantic sturgeon due to impingement at the IP1, IP2 and IP3 intake trash bars and intakes screens.

As explained in the "Effects of the Action" section, effects of the facilities on shortnose and Atlantic sturgeon also include effects of the thermal plume on distribution and prey. However, based on the available information on the thermal plume and the assumptions regarding sturgeon behavior and thermal tolerances outlined in the Opinion, we do not anticipate or exempt any take of shortnose or Atlantic sturgeon due to effects to prey items or due to exposure to the thermal plume.

We expect adult shortnose sturgeon and adult and subadult Atlantic sturgeon from the New York Bight, Gulf of Maine and Chesapeake Bay DPSs with body widths greater than 3" to be impinged at the trash bars. However, as explained in the Effects of the Action section, we expect that all sturgeon impinged on the trash bars will be dead or stressed prior to the impingement and the cause of death/stressor is currently unknown. This impingement is expected to result from the operation of Indian Point and the presence of the trash bars. These interactions at the trash bars constitute "capture" or "collect" in the definition of "take." Because no monitoring has ever occurred at the trash bars and we do not have information on the number or percentage of sturgeon populations in the area, we have no information on which to base a prediction of future impingement at the trash bars in terms of a specific number of fish or a surrogate measure of incidental take. This ITS exempts the take (capture or collect only, not injure or kill) of all shortnose and Atlantic sturgeon impinged at the trash bars. We anticipate, based on mixed stock analysis of Atlantic sturgeon captured in the action area, that 92% of the Atlantic sturgeon impinged at the intakes will originate from the New York Bight DPS, 6% from the Gulf of Maine DPS and 2% from the Chesapeake Bay DPS.

The continued operation of IP2 and IP3 will result in the impingement of shortnose sturgeon and New York Bight DPS origin Atlantic sturgeon at the intake screens. We expect that some of the sturgeon impinged at the screens will be dead or suffering from injury or illness. Some sturgeon caught in the buckets of the Ristroph screen are likely to have been healthy and free swimming; some of those fish are likely to experience injury or mortality while being transported to the sluice. Other sturgeon that become impinged on the screens are likely to suffer injury or mortality due to their impingement. We also expect that some sturgeon will become tired, disoriented and stressed such that their normal behaviors are impaired or they become injured while in the intake embayment between the trash bars and screens; we expect that these fish will become impinged on the Ristroph screens. Based on the available information, we are not able to determine what portion of these shortnose sturgeon or New York Bight DPS Atlantic sturgeon impinged at the Ristroph screens will fall into each of the above categories. Because we know that there will be impingement mortality (available monitoring results suggest at least an 80% mortality rate for shortnose sturgeon and at least 60% for Atlantic sturgeon), but are not able to accurately predict the mortality rate, we have made the conservative determination that all shortnose and Atlantic sturgeon impinged at the screens will be mortally injured or killed. Sturgeon that are impinged at the Ristroph screens but safely returned (i.e, with no injury) alive to the Hudson River are "captured" or "collected." Other impinged sturgeon will be injured or killed. IP1 and IP2 operate under one license, which is up for renewal, and IP3 operates under a separate license, which is also up for renewal. As a result, "take" will be apportioned to each of the two separate actions.

Between now and September 23, 2035 when the proposed renewed operating license for IP2 will expire, we expect up to 395 shortnose sturgeon and 269 New York Bight DPS Atlantic sturgeon will be impinged at the IP2 intakes (Ristroph screens), inclusive of 2 shortnose sturgeon and 2 Atlantic sturgeon impinged at the IP1 intakes used for IP2 service water. Between now and December 12, 2035 when the proposed renewed operating license for IP3 will expire, we expect up to 167 shortnose sturgeon and 145 New York Bight DPS Atlantic sturgeon will be impinged at the IP3 intakes (Ristroph screens). In total, we expect that over the 23 year period, up to 562 shortnose sturgeon and 414 New York Bight DPS Atlantic sturgeon will be killed as a result of Indian Point operations. We expect the amount of impingement to vary annually; however, the conclusions reached in the Opinion are based on it taking 21 years to reach the total impingement level for IP2 (inclusive of IP1 intakes) and 23 years to reach the total impingement level for IP3. In any given year, we do not expect impingement of shortnose sturgeon to be higher than 71 individuals per year at the IP2 Ristroph screens or higher than 32 individuals per year at the IP3 Ristroph screens. We also do not expect impingement levels to be higher than 50 shortnose sturgeon for more than two consecutive years at IP2 or higher than 26 shortnose sturgeon for more than two consecutive years at IP3. For NYB DPS Atlantic sturgeon, in any year we do not expect impingement to be higher than 27 individuals at the IP2 Ristroph screens or higher than 40 individuals at the IP3 Ristroph screens. We also do not expect impingement levels to be higher than 10 Atlantic sturgeon in two consecutive years at IP2 or higher than 10 Atlantic sturgeon in two consecutive years at IP3.

We recognize that some sturgeon impinged at Indian Point screens are likely to be dead prior to impingement. While it is possible the cause of death is unrelated to the operation of Indian Point, we do not currently have any information to determine whether that is the case. The take level that is exempted is inclusive of "previously killed" fish; this ITS exempts the "collection" or "capture" of these previously killed fish. At this time, because there are no necropsy reports for any sturgeon collected at Indian Point and very little data on the condition of impinged shortnose and Atlantic sturgeon (other than "dead" or "alive" for a few fish), we are unable to predict what percent of the impinged sturgeon are likely to have been killed prior to impingement at Indian Point. Future monitoring, as required by the RPMs and Terms and Conditions, will enable the ITS to serve its function of supporting the reinitiation provision.

Given the impingement of these fish is a result of the operation of Indian Point and given the ESA's definitions of "take" and "fish and wildlife" even the impingement of previously killed fish is considered "incidental take."

This ITS exempts the following take (injure, kill, capture or collect, as described below):

- A total of 2 dead or alive shortnose sturgeon (injure, kill, capture or collect) and 2 dead or alive New York Bight DPS Atlantic sturgeon (injure, kill, capture or collect) impinged at the Unit 1[15] intake screens from now until the IP2 proposed renewed operating license would expire on September 28, 2033.
- A total of 395 dead or alive shortnose sturgeon (injure, kill, capture or collect) and 269 New York Bight DPS Atlantic sturgeon (injure, kill, capture or collect) impinged at Unit 2 intakes (Ristroph screens) from now until the IP2 proposed renewed operating license would expire on September 28, 2033.
- A total of 167 dead or alive shortnose sturgeon (injure, kill, capture or collect) and 145 dead or alive New York Bight DPS Atlantic sturgeon (injure, kill, capture or collect) impinged at the Unit 3 intakes (Ristroph screens) from now until the IP3 proposed renewed operating license would expire on December 12, 2035.
- All shortnose sturgeon with body widths greater than 3" impinged at the IP1, IP2 and IP3 trash racks (capture or collect).
- All Atlantic sturgeon with body widths greater than 3" impinged at the IP1, IP2 and IP3 trash racks (capture or collect). These Atlantic sturgeon will originate from the New York Bight (92%), Gulf of Maine (6%) and Chesapeake Bay DPSs (2%).

We will consider the ITS to be exceeded if any of the following occur:

- More than 2 shortnose sturgeon or more than 2 New York Bight DPS Atlantic sturgeon are impinged at the Unit 1 intake screens from now until the IP2 proposed renewed operating license would expire on September 28, 2033.
- More than 395 shortnose sturgeon are impinged at Unit 2 intakes (Ristroph screens) from now until the IP2 proposed renewed operating license would expire on September 28, 2033.
- More than 269 New York Bight DPS Atlantic sturgeon are impinged at the Unit 2 intakes (Ristroph screens) from now until the IP2 proposed renewed operating license would expire on September 28, 2033.
- More than 167 shortnose sturgeon are impinged at the Unit 3 intakes (Ristroph screens) from now until the IP3 proposed renewed operating license would expire on December 12, 2035.
- More than 145 New York Bight DPS Atlantic sturgeon are impinged at the Unit 3 intakes (Ristroph screens) from now until the IP3 proposed renewed operating license would expire on December 12, 2035.
- More than 71 shortnose sturgeon are impinged at the Unit 2 intakes (Ristroph screens) in any one calendar year.
- More than 27 NYB DPS Atlantic sturgeon are impinged at the Unit 2 Ristroph screens in any one calendar year.

[15] As explained in the Opinion, water withdrawn through the Unit 1 intakes is used for service water for the operation of IP2.

- More than 32 shortnose sturgeon are impinged at the Unit 3 Ristroph screens in any one calendar year.
- More than 40 NYB Atlantic sturgeon are impinged at the Unit 3 Ristroph screens in any one calendar year.
- More than 50 shortnose sturgeon are impinged at the Unit 2 intakes (Ristroph screens) in any two consecutive calendar years.
- More than 26 shortnose sturgeon are impinged at the Unit 3 Ristroph screens in any two consecutive years.
- More than 10 NYB DPS Atlantic sturgeon are impinged at the Unit 2 Ristroph screens in any two consecutive calendar years.
- More than 10 NYB DPS Atlantic sturgeon are impinged at the Unit 3 Ristroph screens in any two consecutive calendar year.
- Any shortnose or Atlantic sturgeon with body widths narrower than 3" are impinged at the IP1, IP2 and IP3 trash racks (capture or collect).
- Any Atlantic sturgeon from the Gulf of Maine, Chesapeake Bay, Carolina, or South Atlantic DPS are impinged at the IP1, IP2 or IP3 screens.
- The proportion of Atlantic sturgeon impinged at the IP1, IP2 and IP3 trash racks is different than: New York Bight (92%), Gulf of Maine (6%) and Chesapeake Bay DPSs (2%).

We do not anticipate the impingement of any Atlantic sturgeon originating from the South Atlantic or Carolina DPSs as we do not expect individuals originating from these DPSs to occur in the action area. The impingement of individuals originating from these DPSs at the trash bars or the intake screens would represent new information that would necessitate reinitiation of consultation. We also do not anticipate the impingement of Chesapeake Bay or Gulf of Maine DPS Atlantic sturgeon at the screens. The impingement of Chesapeake Bay or Gulf of Maine DPS Atlantic sturgeon at the screens would represent new information that would necessitate reinitiation of this consultation.

The Section 9 prohibitions against take apply to live individuals as well as to dead specimens and their parts. The Section 9 prohibitions include "capture" and "collect" in the definition of take, as well as injury and mortality. NMFS recognizes that some shortnose and Atlantic sturgeon that have been killed prior to impingement at the IP facility are likely to become impinged on the intakes at IP1, IP2 and IP3. However, the capture or collection of previously dead animals is prohibited under Section 9 and will be exempted through this ITS. Additionally, NMFS recognizes the potential for some shortnose and Atlantic sturgeon to pass through the trash bars, contact the Ristroph screens and travel down the sluice back to the River without significant injury or mortality. The Section 9 prohibitions on take also apply to the capture or collection of live, uninjured animals even if these animals are released without injury. Thus, it is appropriate for this ITS to also address shortnose and Atlantic sturgeon that are captured or collected at the Ristroph screens and returned to the river unharmed. As no monitoring has taken place at the intakes since 1990, we cannot accurately predict what percentage of sturgeon would be collected at the Ristroph screens without injury or mortality and, therefore, we are not able to refine this estimate of take to separate out the number of fish that will be collected but not killed. Due to the difficulty in determining the cause of death of sturgeon found dead at the intakes and the lack of past necropsy results that would allow us to better assess the likely cause of death of impinged sturgeon, the aforementioned anticipated level of take includes shortnose and Atlantic sturgeon that are killed prior to impingement on the IP intakes. As explained in the Opinion, we do not have sufficient information to predict what percentage of impinged sturgeon were previously killed and merely captured or collected at the facility and sturgeon that died as a result of their impingement at the Indian Point intakes. Therefore, we are not able to further refine this estimate of take into a number of previously dead sturgeon captured or collected at the facility and a number of sturgeon whose death was caused by operation of the facility. In the accompanying Opinion, we determined that the level of anticipated incidental take caused by the operation of IP2 is not likely to result in jeopardy to shortnose sturgeon or to any DPS of Atlantic sturgeon even if IP3 is operating at the same time. Similarly, we determined that the level of anticipated incidental take caused by the operation of IP3 is not likely to result in jeopardy to shortnose sturgeon or to any DPS of Atlantic sturgeon, even if IP2 is operating at the same time.

11.2 Reasonable and Prudent Measures

In order to effectively monitor the effects of this action, it is necessary to monitor the intakes to document the amount of incidental take (i.e., the number of shortnose and Atlantic sturgeon captured, collected, injured or killed) and to examine the shortnose and Atlantic sturgeon that are impinged at the facility. Monitoring minimizes take by providing information on the characteristics of the sturgeon encountered and factors related to interactions that is useful for judging the effectiveness of current measures and for developing more effective measures to avoid and/or minimize future interactions with listed species. Monitoring also serves to check the assumptions and conclusions in the Opinion's analysis, thereby enabling NRC and NMFS to know whether reinitiation of consultation is necessary. We do not anticipate any additional injury or mortality to be caused by removing the fish from the water and examining them as required in the RPMs. Even if there is, any such additional take is exempted as long as the terms and conditions of the ITS are complied with. Any live sturgeon are to be released back into the river, away from the intakes and thermal plume. These RPMs and their implementing terms and conditions apply to operations of IP2 and IP3 under their existing licenses as well as the license to be issued for the continued operation of IP2 and the license to be issued for the continued operation of IP3.

We have determined the following reasonable and prudent measures are necessary or appropriate to minimize and monitor impacts of incidental take of endangered shortnose and Atlantic sturgeon:

1. A program to monitor the incidental take of shortnose and Atlantic sturgeon at the IP1, IP2 and IP3 intakes must be developed, approved by NMFS, and implemented as described in the Terms and Conditions. This program must be implemented throughout the remaining duration of the existing IP2 and IP3 operating licenses as well as during the time IP2 and/or IP3 operate pursuant to the proposed renewed operating license(s).

2. All live, incidentally taken shortnose and Atlantic sturgeon must be released back into the Hudson River at an appropriate location away from the intakes and thermal plume that does not pose additional risk of take, including death, injury, harassment, collection/capture.

3. Any dead, incidentally taken shortnose or Atlantic sturgeon must be transferred to NMFS or an appropriately permitted research facility NMFS will identify so that a necropsy can be undertaken to attempt to determine the cause of death.

4. A genetic sample must be taken of all incidentally taken Atlantic and shortnose sturgeon.

5. All incidental takes of shortnose and Atlantic sturgeon associated with the Indian Point facilities and any shortnose or Atlantic sturgeon sightings in the action area must be reported to NMFS.

11.3 Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, Entergy must comply with, and NRC, consistent with its authorities, must ensure through enforceable terms of the existing and renewed licenses that Entergy does comply with, the following terms and conditions of the Incidental Take Statement, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this ITS shall not be considered a prohibited taking of the species concerned (ESA Section 7(o)(2)). With regard to the existing licenses for IP2 and IP3: upon issuance of this Opinion, NRC shall take prompt and effective action to require Entergy to adhere to the terms and conditions of this ITS. With regard to the proposed renewed licenses for IP2 and IP3: NRC shall ensure that each renewed license contains a condition that requires Entergy to adhere to the terms and conditions of this ITS upon issuance of the renewed license(s).

1. To implement RPM #1, Entergy must develop a proposed, draft monitoring plan designed to document all shortnose and Atlantic sturgeon impinged at IP1, IP2 and IP3 (trash racks and intake screens) while these facilities are operating under their existing operating licenses and the proposed renewed operating licenses. The draft monitoring plan must be provided to NMFS and NRC within 60 days of the issuance of this Opinion for NMFS review and approval. NMFS may: (1) revise the draft plan and approve it as revised; (2) provide comments to NRC and Entergy noting changes that Entergy needs to make; or (3) approve the plan as submitted. If NMFS determines modifications to the draft plan are appropriate and provides comments, Entergy must submit a modified draft plan to NMFS within 30 days of receiving the comments. NMFS retains sole discretion to determine the final contents of the plan. The draft monitoring plan must contain an implementation schedule for each of the components noted below. The plan must be fully implemented within 120 days of NMFS final approval, unless additional time is necessary to obtain approvals required by law from NRC or the State of New York or because physical plant alterations are necessary to implement a monitoring component; requirements related to those circumstances are provided below. NMFS final approval of the monitoring plan will include an approval of the implementation schedule. The monitoring plan must be designed and implemented to allow for the detection and observation of all shortnose and Atlantic sturgeon that are impinged anywhere at the intakes, including on the trash bars, or that are impinged at the screens or captured in the fish buckets. All references to intake screens below are inclusive of all parts of the intake screen systems at IP1, IP2, and IP3 including the screening itself, the fish buckets, and the fish return system. This monitoring plan must contain the following components:

a. An implementation schedule for each of the components noted below. The implementation schedule must identify the timeline for implementing each of the following components of the monitoring plan. For all components, Entergy must identify any approvals that are required by law from NRC or the State of New York as well as the specific statutory requirement and the anticipated timeframe associated with obtaining those approvals. In those instances, Entergy must identify the steps they will take to obtain those approvals and the anticipated timeline for implementing that component of the monitoring plan. The implementation schedule for each component must also identify any physical plant alterations that are necessary to allow each component to be implemented, steps that must be taken to make these alterations and the timeline for making these alterations. In instances where a portion of the monitoring component could be implemented without additional approvals and/or physical plant alterations, implementation must occur within 120 days of NMFS approval of the monitoring plan.

b. methods and procedures for monitoring the intake trash bars on a schedule that ensures detection of all shortnose and Atlantic sturgeon impinged on the trash bars and timely collection and release of any live shortnose and Atlantic sturgeon that minimizes the opportunity for injury and timely collection of any dead shortnose and Atlantic sturgeon that minimizes the opportunity for decomposition;

c. any method developed to monitor the intake trash bars for shortnose and Atlantic sturgeon must be able to detect all individuals impinged at the trash bars within 24 hours of impingement;

d. methods and procedures for monitoring the intake embayment (area behind the trash bars and including the intake screens) on a schedule that ensures detection of all shortnose and Atlantic sturgeon that are in the embayment either in the water or impinged on the intake screens, including those captured in the fish buckets;

e. any method developed to monitor the intake embayment, including the intake screen system must ensure the detection and capture of all shortnose and Atlantic sturgeon such that live sturgeon can be inspected and assessed for injury and dead shortnose and Atlantic sturgeon can be retained for necropsy;

f. procedures to monitor the collection efficiency for Atlantic and shortnose sturgeon (i.e., fraction of fish that enter the intake structure but do not make it into impingement collections).

g. a handling and release plan that describes how all live shortnose and Atlantic sturgeon that are impinged at the trash bars or found in the intake embayment, including those impinged on the intake screens, will be safely removed from the water, handled for examination, and returned to the River; handling and disposal procedures for all dead shortnose and Atlantic sturgeon or body parts of shortnose and Atlantic sturgeon;

h. procedures for obtaining genetic samples from all shortnose and Atlantic sturgeon collected at the intakes;

i. reporting forms that contain all information to be reported for all incidental takes of shortnose and Atlantic sturgeon;

j. procedures for notifying NMFS of all incidental takes;

k. measuring the actual water velocity at the trash bars (approach and through-rack velocity), between the trash bars and screens and at the screens (approach and through-screen velocity) at IP1, IP2 and IP3 so that this information can be reported any time a take occurs;

l. measuring actual water temperature at the trash bars and at the Ristroph screens at IP1, IP2 and IP3 (surface, mid-water and bottom water) so that this information can be reported any time a take occurs. If existing thermal monitoring accurately documents water temperatures in these areas, the monitoring plan should explain why additional thermal monitoring is not necessary and demonstrate how existing thermal monitoring meets the requirements of this component;

m. monitoring operating conditions so that this information can be reported any time a take occurs. Operating conditions to be reported include: number of pumps running, their speed and pumping volumes, number of reactors operating, reactor power levels at time of observation, reactor power levels in previous 48 hours, and any other notable operational observations or events within previous 48 hours (e.g., shutdowns, restarts, etc.);

n. coordination procedures regarding personnel who will be carrying out this monitoring. Qualifications must be submitted to NMFS for review and approval. All monitors will need to demonstrate experience in identifying and handling sturgeon species.

o. any other component determined to be necessary or appropriate to monitor incidental take.

and,

p. procedures for making any necessary updates or modifications to the monitoring plan.

2. To implement RPM #1, the final NMFS approved monitoring plan must be implemented as approved by NMFS throughout the period during which the facilities operate pursuant to the existing operating licenses. The monitoring plan must also continue to be implemented through the duration of the operating period authorized by any new operating licenses issued by NRC for IP2 and/or IP3.

3. To implement RPM #2, Entergy must ensure that all live shortnose and Atlantic sturgeon removed from the trash racks, intake embayment (including screens and buckets) or fish return system, are returned to the river away from the intakes and the thermal plume, following complete documentation of the event pursuant to the approved monitoring plans and forms provided with this ITS as required by Term and Condition #1.

4. To implement RPM #3, Entergy must ensure that all dead specimens or body parts of shortnose and Atlantic sturgeon or fish that might be sturgeon retrieved from the Indian Point intakes are photographed, measured, and preserved (refrigerate or freeze). No dead shortnose or Atlantic sturgeon or body parts of shortnose or Atlantic sturgeon may be

disposed without discussing disposal procedures with NMFS for each fish or part thereof. NMFS may request that the specimen be transferred to NMFS or to an appropriately permitted researcher so that a necropsy can be conducted. The forms included as Appendix II and III must be completed and submitted to NMFS as noted in Term and Condition #7.

5. To implement RPM#4, Entergy must obtain genetic samples from all captured or collected (including impinged) Atlantic and shortnose sturgeon. This must be done in accordance with the procedures provided in Appendix IV.

6. To implement RPM #5, if any live or dead shortnose or Atlantic sturgeon are taken (e.g., captured, collected, killed, injured) at IP1, IP2 or IP3, Entergy must notify NMFS (978-281-9328 and incidental.take@noaa.gov) and NRC (endangeredspecies@nrc.gov) within 24 hours. An incident report (Appendix I) must also be completed by plant personnel and sent to the NMFS Section 7 Coordinator via e-mail (incidental.take@noaa.gov) within 24 hours of the take. The form included as Appendix III must be filled out for any dead sturgeon and submitted via e-mail (incidental.take@noaa.gov) within 24 hours of the take. Every shortnose and Atlantic sturgeon collected at the Indian Point intakes, must be photographed and photographs must be submitted to NMFS within 24 hours (incidental.take@noaa.gov). Information in Appendix V will assist in identification of shortnose and Atlantic sturgeon.

7. To implement RPM #5, Entergy must submit an annual report of all incidental takes to NMFS and NRC by February 15 of each year (reporting on takes that occurred in the previous calendar year). The report must include, as detailed in this Incidental Take Statement and the monitoring plan required by Term and Condition #1 and #2, any necropsy reports of specimens, incidental take reports, photographs , a record of all sightings of shortnose and Atlantic sturgeon in the vicinity of Indian Point, conditions at the time of the take (operations as well as environmental conditions including water velocity and water temperature) and a record of when inspections of the intake trash bars and Ristroph screens were conducted for the 48 hours prior to the take. The annual report must also identify any potential measures to reduce shortnose or Atlantic sturgeon impingement, injury, and mortality at the intake structures along with any plans to implement those measures. At the time the report is submitted, NMFS will supply NRC and Entergy with any information on changes to reporting requirements (i.e., staff changes, phone or fax numbers, e-mail addresses) for the coming year. This report must be submitted via e-mail (incidental.take@noaa.gov) or U.S. mail (Attn: Section 7 Coordinator, NMFS NERO Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930).

8. To implement RPM#5, following the submittal of the annual report, but prior to April 15 of each year, a conference call or in person meeting between Entergy, NMFS and NRC will be held during which the take information for the previous year will be discussed. NMFS will use the information presented in each annual report, in addition to other sources of information, to determine if there is any new information on effects of the action that were not anticipated in this Opinion. At this time, we anticipate this type of new information could include a higher than anticipated impingement of any species of

sturgeon, different size classes of fish impinged than anticipated, different condition of fish impinged than anticipated, or different percent of Atlantic sturgeon from the different DPSs than anticipated. This annual meeting or conference call will also be used to review the requirements of the monitoring plan and to discuss any changes to the monitoring plan that NMFS, NRC or Entergy believe are necessary.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that results from the proposed action. Specifically, these RPMs and Terms and Conditions will ensure that Entergy monitors the intakes in a way that allows for the detection of all impinged shortnose and Atlantic sturgeon and implements measures to reduce the potential of mortality for all shortnose and Atlantic sturgeon impinged at Indian Point, to report all interactions to NMFS and NRC and to provide information on the likely cause of death of any dead shortnose and Atlantic sturgeon impinged at the facility. The discussion below explains why each of these RPMs and Terms and Conditions are necessary or appropriate to minimize or monitor the level of incidental take associated with the proposed action. The RPMs and terms and conditions involve only a minor change to the proposed action. We have determined that incidental take of shortnose and Atlantic sturgeon includes impingement on the trash bars and impingement at the intake screens (which includes collection in the fish buckets). The RPMs and Terms and Conditions ensure that all incidental take is monitored and reported to NRC and NMFS.

RPM #1 and Term and Condition #1 and 2 require Entergy to design and implement a monitoring plan that will allow for the detection and collection of all shortnose and Atlantic sturgeon at the Indian Point intakes, whether impinged at the trash bars, impinged on the intake screen system (which includes collection in the fish buckets), or in the intake embayment behind the trash bars prior to impingement on the intake screen system. Removing sturgeon from the intake embayment before they interact with the screen system minimizes incidental take caused by impingement on the screens. An effective monitoring plan is essential to ensure NRC and Entergy monitor the level of incidental take that occurs during the license periods and to enable NMFS and NRC to determine whether the incidental take level in this ITS is exceeded, thereby triggering reinitiation of consultation. These requirements are necessary and appropriate because they are specifically designed to ensure that all appropriate measures are carried out to monitor the incidental take of sturgeon at Indian Point, which by definition includes the capture or collection of live sturgeon as well as the injury or mortality of impinged sturgeon. These requirements are also essential for confirming the cause of death of any sturgeon that are dead when collected These conditions ensure that the potential for detection of shortnose and Atlantic sturgeon at the intakes is maximized and that any sturgeon removed from the water are removed in a manner that minimizes the potential for further injury. Monitoring actual collection efficiency is necessary or appropriate to determine how many sturgeon enter the intake structure but do not make it into impingement collections. We do not believe that the handling of impinged sturgeon will result in an increased risk of injury or mortality if proper handling procedures are implemented, which the monitoring plan will include. For example, both shortnose and Atlantic sturgeon are routinely captured in a trawl survey in the Hudson River that the applicant participates in. Captured sturgeon are brought into the boat, removed from the trawl gear, weighed, measured and tagged. There have been no reported instances of injury or mortality to any of the hundreds of Atlantic or shortnose sturgeon captured during this survey in over twenty years. Similarly, sturgeon that enter the fish lift at the Holyoke Hydroelectric facility on the Connecticut River are netted, removed from the water, weighed, measured and tagged. There have been no reports of any injuries or mortalities to sturgeon caused by these handling procedures. The RPMs and Terms and Conditions related to monitoring do not dictate the details of the plan (i.e., how Entergy must monitor the trash racks or intake screens) to allow Entergy the flexibility to design the monitoring plan in a way that minimizes impacts to project operations and results in no more than a minor change to the operations of Indian Point 2 and 3. While we believe the enumerated, specific components are sufficient to monitor incidental take, review of Entergy's draft monitoring plan and/or other information may lead NMFS to believe that additional or different monitoring plan components may be necessary or appropriate. Therefore, NMFS may design or have Entergy propose, additional or different monitoring components that NMFS determines are necessary or appropriate to monitor incidental take.

RPM#2 and Term and Condition #3 are necessary and appropriate to ensure that any shortnose or Atlantic sturgeon that survive impingement is given the maximum probability of remaining alive and not suffering additional injury or subsequent mortality through inappropriate handling or release near the intakes. This RPM and Term and Condition serve to minimize lethal take.

RPM #3 and Term and Condition #4 are necessary and appropriate to ensure the proper handling and documentation of any shortnose and Atlantic sturgeon removed from the intakes that are dead or die while in Entergy possession. This is essential for monitoring the level of incidental take associated with the proposed action, confirming cause of death and ensuring proper disposal.

RPM #4 and Term and Condition #5 are necessary and appropriate to ensure the proper documentation of species and/or DPS of origin for any impinged sturgeon collected at Indian Point. Sampling of fin tissue is used for genetic sampling. This procedure does not harm shortnose or Atlantic sturgeon and is common practice in fisheries science. Tissue sampling does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact. NMFS has received no reports of injury or mortality to any shortnose or Atlantic sturgeon sampled in this way.

RPM#5 and Term and Condition #6-8 are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as the prompt reporting of these interactions to NMFS. This is necessary to allow NMFS to monitor the level of take and to determine if take is exceeded or if any other triggers for reinitiation have been met. This RPM and Term and Condition also ensure that NMFS, NRC and Entergy will continue to monitor the effectiveness of the monitoring program and make any changes that may be necessary to the monitoring program in the future.

12.0 CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. As such, NMFS recommends that the NRC consider the following Conservation Recommendations:

1. The NRC should use its authorities to ensure tissue analysis of dead shortnose sturgeon removed from the Indian Point intakes is performed to determine contaminant loads, including radionuclides.

2. The NRC should use its authorities to ensure studies are performed that document impacts of impingement, entrainment and heat shock to benthic resources that may serve as forage for shortnose and Atlantic sturgeon.

3. The NRC should use its authorities to ensure studies are performed to ground truth the thermal plume model published in 2011 (Swanson et al. 2011) with field sampling across a range of environmental conditions (weather, tide, etc.).

4. The NRC should use its authorities to require that the REMP sample species that may serve as forage for shortnose and Atlantic sturgeon.

5. The NRC should use its authorities to ensure a scientific study on the mortality of sturgeon impinged on Ristroph Screens is performed.

6. The NRC should use its authorities to ensure in-water assessments, abundance, and distribution surveys for shortnose and Atlantic sturgeon in the Hudson River, and Haverstraw Bay specifically, are performed.

7. The NRC should use its authorities to ensure studies are performed that document the presence, if any, of shortnose sturgeon in the broadest area affected by the thermal plume in order to validate the assumption in this Opinion that shortnose sturgeon are likely to move away from the thermal plume.

13.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the continued operation of IP2 and IP3 under the terms of the existing operating licenses and the proposed renewed operating licenses. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

If in the future, NY State issues a revised SPDES permit or 401 WQC that modifies the operations of IP2 or IP3, reinitiation of this consultation is likely to be necessary. Additionally, it is our understanding that revised CWA 316(b) regulations may be issued by EPA in 2013. If there are any modifications to the Indian Point facility resulting from the implementation of these regulations, reinitiation of this consultation is likely to be necessary. Reinitiation of consultation will also be necessary if NRC or Entergy fail to implement the terms and conditions of the ITS or are otherwise not in compliance with the ITS.

14.0 LITERATURE CITED

Allen PJ, Nicholl M, Cole S, Vlazny A, Cech JJ Jr. 2006. Growth of larval to juvenile green sturgeon in elevated temperature regimes. Trans Am Fish Soc 135:89–96

ASA (Analysis and Communication). 2008. 2006 year class report for the Hudson River Estuary Program prepared for Dynegy Roseton LLC, on behalf of Dynegy Roseton LLC Entergy Nuclear Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, and Mirant Bowline LLC. Washingtonville NY.

ASMFC (Atlantic States Marine Fisheries Commission). 2009. Atlantic Sturgeon. Pages 19-20 in Atlantic States Marine Fisheries Commission 2009 Annual Report. 68 pp.

ASSRT (Atlantic Sturgeon Status Review Team). 2007. Status review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M., K. Arend, N. Haley, S. Hayes, J. Knight, S. Nack, D. Peterson, and M. Walsh. 1998a. Sturgeon of the Hudson River: Final Report on 1993-1996 Research. Prepared for The Hudson River Foundation by the Department of Natural Resources, Cornell University, Ithaca, New York.

Bain, Mark B., D.L. Peterson, K. K. Arend. 1998b. Population status of shortnose sturgeon in the Hudson River: Final Report. Prepared for Habitat and Protected Resources Division National Marine Fisheries Service by New York Cooperative Fish and Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY.

Bain, Mark B., N. Haley, D. L. Peterson, K. K. Arend, K. E. Mills, P. J. Sullivan. 2000. Annual meeting of American fisheries Society. EPRI-AFS Symposium: Biology, Management and Protection of Sturgeon. St. Louis, MO. 23-24 August 2000.

Bain, Mark B., N. Haley, D. L. Peterson, K. K Arend, K. E. Mills, P. J. Sulivan. 2007. Recovery of a US Endangered Fish. PLoS ONE 2(1): e168. doi:10.1371/journal.pone.0000168

Balazik, M.T., G.C. Garman, M.L. Fine, C.H. Hager, and S.P. McIninch. 2010. Changes in age composition and growth characteristics of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) over 400 years. Biology Letters Online, 17 March 2010. 3 pp.

Bath, D.W., J.M. O'Conner, J.B. Albert and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrinchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981:711-717.

Beamesderfer, Raymond C.P. and Ruth A. Farr. 1997. Alternatives for the protection and restoration of sturgeons and their habitat. Environmental Biology of Fishes 48: 407-417.

Berlin, W.H., R.J. Hesselberg, and M.J. Mac. 1981. Chlorinated hydrocarbons as a factor in the reproduction and survival of lake trout (Salvelinus namaycush) in Lake Michigan. Technical Paper 105 of the U.S. Fish and Wildlife Service, 42 pages.

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin, U.S. Fish and Wildlife Service 74(53). 577 pp.

Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. Environmental Biology of Fishes 48:399-405.

Borodin, N. 1925. Biological observations on the Atlantic sturgeon, *Acipenser sturio*. Transactions of the American Fisheries Society 55:184-190.

Boysen, K. A. and Hoover, J. J. (2009), Swimming performance of juvenile white sturgeon (Acipenser transmontanus): training and the probability of entrainment due to dredging. Journal of Applied Ichthyology, 25: 54–59.

Brown, J.J., and G.W. Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. Fisheries 35(2):72-83Buckley, J., and B. Kynard. 1981. Spawning and rearing of shortnose sturgeon from the Connecticut River. Progressive Fish Culturist 43:74-76.

Buckley, J.A. 1974. Acute toxicicy of residual chlorine in wastewater on coho salmon (Oncorhvnchus kisucch) and some resultant hemacologic changes. Jour. Fish. Res. Board Can. 33: 2854.

Buckley, J. and B. Kynard. 1985. Habitat use and behavior of pre-spawing and spawning shortnose sturgeon, *Acipenser brevirostrum*, in the Connecticut River. North American Sturgeons: 111-117.

Bushnoe, T.M., J.A. Musick, and D.S. Ha. 2005. Essential spawning and nursery habitat of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in Virginia. VIMS Special Scientific Report 145. 44 pp.

Calvo, L., H.M. Brundage, D. Haivogel, D. Kreeger, R. Thomas, J.C. O'Herron, and E. Powell. 2010. Effects of flow dynamics, salinity, and water quality on the Eastern oyster, the Atlantic sturgeon, and the shortnose sturgeon in the oligohaline zone of the Delaware Estuary. Prepared for the U.S. Army Corps of Engineers, Philadelphia District. 108 pp.

Campbell, J. and Davidson T. 2007. Summary of Kootenai River White Sturgeon Studies. U. S. Fish and Wildlife Service Upper Columbia Fish and Wildlife Office, Spokane, Washington 2007/2008. Available at: http://www.kootenai.org/documents/USFWSSummaryforKRProjects8.19.08.pdf

Carlson, D.M., and K.W. Simpson. 1987. Gut contents of juvenile shortnose sturgeon in the upper Hudson estuary. Copeia 1987:796-802

Caron, F., D. Hatin, and R. Fortin. 2002. Biological characteristics of adult Atlantic sturgeon (*Acipenser oxyrinchus*) in the Saint Lawrence River estuary and the effectiveness of management rules. Journal of Applied Ichthyology 18:580-585.

CHGE. Central Hudson Gas and Electric Corp., Consolidated Edison Company of New York, New York Power Authority, and Southern Energy New York. 1999. Draft environmental impact statement for State pollution discharge elimination system permits for Bowline Point1&2, Indian Point 1&2, and Roseton 1&2 Steam electric generating stations.

Collins, M.R., and T.I.J. Smith. 1997. Distribution of shortnose and Atlantic sturgeons in South Carolina. North American Journal of Fisheries Management 17:995-1000.

Collins, M. R., S. G. Rogers, and T. I. J. Smith. 1996. Bycatch of sturgeons along the Southern Atlantic Coast of the USA. North American Journal of Fisheries Management 16: 24-29.

Collins, M.R., S.G. Rogers, T.I.J. Smith, and M.L. Moser. 2000. Primary factors affecting sturgeon populations in the southeastern United States: fishing mortality and degradation of essential habitats. Bulletin of Marine Science 66:917-928.

Crance, J.H. 1987. Habitat suitability index curves for anadromous fishes. *In*: Common Strategies of Anadromous and Catadromous Fishes, M.J. Dadswell (ed.). Bethesda, Maryland, American Fisheries Society. Symposium 1:554.

Dadswell, M. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. Fisheries 31:218-229.

Dadswell, M.J. 1979. Biology and population characteristics of the shortnose sturgeon, Acipenser brevirostrum LeSueur 1818 (Osteichthyes: Acipenseridae), in the Saint John River estuary, New Brunswick, Canada. Canadian Journal of Zoology 57:2186-2210.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* Lesueur 1818. NOAA Technical Report, NMFS 14, National Marine Fisheries Service. October 1984 45 pp.

Damon-Randall, K. 2012a. Composition of Atlantic Sturgeon in Rivers, Estuaries and Marine Waters. NMFS NERO Protected Resources Division. Unpublished report. 31 pp.

Dees, L.T. 1961. Sturgeons. USFWS Fishery Leaflet 526. 8 pp.

Deslauriers, D. and J.D. Kieffer (2012). Swimming performance and behaviour of young-of-the year shortnose sturgeon (Acipenser brevirostrum) under fixed and increased velocity tests. Canadian Journal of Zoology, 90: 345-351.

Deslauriers, D. and J.D. Kieffer (2012). The effects of temperature on swimming performance of juvenile shortnose sturgeon (Acipenser brevirostrum). J. Applied Ichthyology 28: 176–181.

DFO (Division of Fisheries and Oceans). 2011. Atlantic Sturgeon and Shortnose Sturgeon Maritimes Region Summary Report. U.S. Sturgeon Workshop. Alexandria, Virginia, 8-10 February 2011. 11 pp.

Dovel, W.J. 1978. The Biology and management of shortnose and Atlantic sturgeons of the Hudson River. Performance report for the period April 1, to September 30, 1978. Submitted to N.Y. State Department of Environmental Conservation.

Dovel, W.J. 1979. Biology and management of shortnose and Atlantic sturgeon of the Hudson River. New York State Department of Environmental Conservation, AFS9-R, Albany.

Dovel, W.L. 1981. The Endangered shortnose sturgeon of the Hudson Estuary: Its life history and vulnerability to the activities of man. The Oceanic Society. FERC Contract No. DE-AC 39-79 RC-10074.

Dovel, W.L., and T.J. Berggren. 1983. Atlantic sturgeon of the Hudson River estuary, New York. New York Fish and Game Journal 30:140-172.

Dovel, W.L., A.W. Pekovitch, and T.J. Berggren. 1992. Biology of the shortnose sturgeon (*Acipenser brevirostrum* Lesueur 1818) in the Hudson River estuary, New York. Pages 187-216 in C.L. Smith (editor). Estuarine research in the 1980s. State University of New York Press, Albany, New York.

Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.J. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. Fishery Bulletin 108:450-465.

Dwyer, F. James, Douglas K. Hardesty, Christopher G. Ingersoll, James L. Kunz, and David W. Whites. 2000. Assessing contaminant sensitivity of American shad, Atlantic sturgeon, and shortnose sturgeon. Final Report. U.S. Geological Survey. Columbia Environmental Research Center, 4200 New Have Road, Columbia, Missouri.

Entergy Nuclear Operations, Inc. (Entergy). 2007a. "Indian Point, Units 2 & 3, License Renewal Application." April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. "Applicant's Environment Report, Operating License Renewal Stage." (Appendix E to "Indian Point, Units 2 & 3, License Renewal Application".) April 23, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2007c. Letter from Fred Dacimo, Indian Point Energy Center Site Vice President, to the U.S. NRC regarding Indian Point Nuclear Generating Units Nos. 2 and 3. Docket Nos. 50-247, 50-286. May 3, 2007.

Entergy Nuclear Operations, Inc. (Entergy). 2012. Atlantic sturgeon and shortnose sturgeon impingement at IPEC Units 2 and 3: Review of Historical Data, Projections of Impingement, and Assessment of the Condition of Impinged Sturgeon Upon Arrival at IPEC. Prepared by AKRF, Inc., Normandeau Associates Inc., ASA Analysis and Communications, Inc., and LWB Environmental Services, Inc. July 23, 2012.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2002. Contaminant analysis of tissues from two shortnose sturgeon (Acipenser brevirostrum) collected in the Delaware River. Prepared for National Marine Fisheries Service. 16 pp. + appendices.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2007. Preliminary acoustic tracking study of juvenile shortnose sturgeon and Atlantic sturgeon in the Delaware River. May 2006 through March 2007. Prepared for NOAA Fisheries. 9 pp.

Erickson, D.L., A. Kahnle, M.J. Millard, E.A Mora, M. Bryja, A. Higgs, J. Mohler, M. DuFour, G. Kenney, J. Sweka, and E.K. Pikitch. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus* Mitchell, 1815. Journal of Applied Ichthyology 27:356-365.

Eyler, Sheila M., Jorgen E. Skjeveland, Michael F. Mangold, and Stuart A. Welsh. 2000. Distribution of Sturgeons in Candidate Open Water Dredged Material Placement Sites in the Potomac River (1998-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 26 pp.

Eyler, S., M. Mangold, and S. Minkkinen. 2004. Atlantic coast sturgeon tagging database. Summary Report prepared by U.S. Fish and Wildlife Service, Maryland Fishery Resource Office, Annapolis, Maryland. 51 pp.

Fernandes, S.J. 2008. Population demography, distribution, and movement patterns of Atlantic and shortnose sturgeons in the Penobscot River estuary, Maine. University of Maine. Masters thesis. 88 pp.

Fernandes, S.J., G. Zydlewski, J.D. Zydlewski, G.S. Wippelhauser, and M.T. Kinnison. 2010. Seasonal distribution and movements of shortnose sturgeon and Atlantic sturgeon in the Penobscot River Estuary, Maine. Transactions of the American Fisheries Society 139(5):1436-1449.

Fisher, M. 2009. Atlantic Sturgeon Progress Report. State Wildlife Grant Project T-4-1. Delaware Division of Fish and Wildlife Department of Natural Resources and Environmental Control. Smyrna, Delaware. 24 pp.

Fisher, M. 2011. Atlantic Sturgeon Final Report. State Wildlife Grant Project T-4-1. Delaware Division of Fish and Wildlife Department of Natural Resources and Environmental Control. Smyrna, Delaware. 44 pp.

Fletcher, R. I. 1990. Flow dynamics and fish recovery experiments: water intake systems. Transactions of the American Fisheries Society. Vol. 119, No. 3, pp. 393-415.

Flournoy, P.H., S.G. Rogers, and P.S. Crawford. 1992. Restoration of shortnose sturgeon in the Altamaha River, Georgia. Final Report to the U.S. Fish and Wildlife Service, Atlanta, Georgia.

Geoghegan, P., M.T. Mattson and R.G Keppel. 1992. Distribution of shortnose sturgeon in the Hudson River, 1984-1988. IN Estuarine Research in the 1980s, C. Lavett Smith, Editor. Hudson River Environmental Society, Seventh symposium on Hudson River ecology. State University of New York Press, Albany NY, USA.

Giesy, J.P., J. Newsted, and D.L. Garling. 1986. Relationships between chlorinated hydrocarbon concentrations and rearing mortality of chinook salmon (Oncorhynchus tshawytscha) eggs from Lake Michigan. Journal of Great Lakes Research 12(1):82-98.

Gilbert, C.R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82, 28 pages.

Greene CH, Pershing AJ, Cronin TM and Ceci N. 2008. Arctic climate change and its impacts on the ecology of the North Atlantic. Ecology 89:S24-S38.

Grunwald, C., J. Stabile, J.R. Waldman, R. Gross, and I. Wirgin. 2002. Population genetics of shortnose *sturgeon (Acipenser brevirostrum*) based on mitochondrial DNA control region sequences. Molecular Ecology 11: 000-000.

Guilbard, F., J. Munro, P. Dumont, D. Hatin, and R. Fortin. 2007. Feeding ecology of Atlantic sturgeon and lake sturgeon co-occurring in the St. Lawrence Estuarine Transition Zone. American Fisheries Society Symposium 56:85-104.

Hansen, P.D. 1985. Chlorinated hydrocarbons and hatching success in Baltic herring spring spawners. Marine Environmental Research 15:59-76.

Haley, N. 1996. Juvenile sturgeon use in the Hudson River Estuary. Master's thesis. University of Massachusetts, Amhearst, MA, USA.

Haley, N.J. 1999. Habitat characteristics and resource use patterns of sympatric sturgeons in the Hudson River estuary. Master's thesis. University of Massachusetts, Amherst.

Hall, W.J., T.I.J. Smith, and S.D. Lamprecht. 1991. Movements and habitats of shortnose sturgeon Acipenser brevirostrum in the Savannah River. Copeia (3):695-702.

Hastings, R.W. 1983. A study of the shortnose sturgeon (*Acipenser brevirostrum*) population in the upper tidal Delaware River: Assessment of impacts of maintenance dredging. Final Report to the U.S. Army Corps of Engineers, Philadelphia, Pennsylvania. 129 pp.

Hatin, D., R. Fortin, and F. Caron. 2002. Movements and aggregation areas of adult Atlantic sturgeon (*Acipenser oxyrinchus*) in the Saint Lawrence River estuary, Quebec, Canada. Journal of Applied Ichthyology 18:586-594.

Heidt, A.R., and R.J. Gilbert. 1978. The shortnose sturgeon in the Altamaha River drainage, Georgia. Pages 54-60 in R.R. Odum and L. Landers, editors. Proceedings of the rare and endangered wildlife symposium. Georgia Department of Natural Resources, Game and Fish Division, Technical Bulletin WL 4, Athens, Georgia.

Hildebrand, S.F., and W.C. Schroeder. 1928. Fishes of the Chesapeake Bay. Washington, D.C.: Smithsonian Institute Press.

Holland, B.F., Jr. and G.F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources, Division of Commercial and Sports Fisheries, Morehead City. Special Scientific Report 24:1-132.

Holton, J.W., Jr., and J.B. Walsh. 1995. Long-Term Dredged Material Management Plan for the Upper James River, Virginia. Virginia Beach, Waterway Surveys and Engineering, Limited. 94 pp.

Hoover, J. J., Boysen, K. A., Beard, J. A. and Smith, H. (2011), Assessing the risk of entrainment by cutterhead dredges to juvenile lake sturgeon (*Acipenser fulvescens*) and juvenile pallid sturgeon (*Scaphirhynchus albus*). Journal of Applied Ichthyology, 27: 369–375.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43: 617-627.IPCC (Intergovernmental Panel on Climate Change) 2007. Fourth Assessment Report. Valencia, Spain.

IPCC (Intergovernmental Panel on Climate Change). 2007. Summary for Policymakers. *In* S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (editors). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

Intergovernmental Panel on Climate Change (IPCC). 2007a. Climate Change 2007 – Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC. IPCC, Geneva.

Intergovernmental Panel on Climate Change (IPCC). 2007b. Climate Change 2007 - The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. IPCC, Geneva.

Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1993. Tolerance of shortnose sturgeon, *Acipenser brevirostrum*, juveniles to different salinity and dissolved oxygen concentrations. Proceedings of the Southeast Association of Fish and Wildlife Agencies, Atlanta, Georgia.

Johnson, J.H., D.S. Dropkin, B.E. Warkentine, J.W. Rachlin, and W.D. Andres. 1997. Food habits of Atlantic sturgeon off the New Jersey coast. Transactions of the American Fisheries Society 126:166-170.

Kahnle, A.W., K.A. Hattala, and K.A. McKown. 2007. Status of Atlantic sturgeon of the Hudson River Estuary, New York, USA. American Fisheries Society Symposium 56:347-363.

Kieffer, M.C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 1221: 1088-1103.

Kieffer, M., and B. Kynard. 1996. Spawning of shortnose sturgeon in the Merrimack River. Transactions of the American Fisheries Society 125:179-186.

Kocan, R.M., M.B. Matta, and S. Salazar. 1993. A laboratory evaluation of Connecticut River coal tar toxicity to shortnose sturgeon (*Acipenser brevirostrum)* embryos and larvae. Final Report to the National Oceanic and Atmospheric Administration, Seattle, Washington.

Kynard, B. 1996. Twenty-one years of passing shortnose sturgeon in fish lifts on the Connecticut River: what has been learned? Draft report by National Biological Service, Conte Anadromous Fish Research Center, Turners Falls, MA. 19 pp.

Kynard, B. 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon, Acipenser brevirostrum. Environmental Biology of Fishes 48:319–334.

Kynard, B., and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*, and shortnose sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63:137-150.

Kynard, B., D. Pugh and T. Parker. 2005. Experimental studies to develop a bypass for shortnose sturgeon at Holyoke Dam. Final report to Holyoke Gas and Electric, Holyoke, MA.

Kynard, B., P. Bronzi and H. Rosenthal, eds. Life History and Behaviour of Connecticut River Shortnose and Other Sturgeons. Special Publication 4 of the World Sturgeon Conservation Society. Chapter 3, Kieffer, M. C., and B. Kynard. Spawning and non-spawning spring migrations, spawning, and effects of hydroelectric dam operation and river regulation on spawning of Connecticut River shortnose sturgeon.

Laney, R.W., J.E. Hightower, B.R. Versak, M. F. Mangold, W.W. Cole Jr., and S.E. Winslow. 2007. Distribution, habitat use, and size of Atlantic sturgeon captured during cooperative winter tagging cruise, 1988-2006. American Fisheries Society Symposium 56:167-182.

Leland, J.G., III. 1968. A survey of the sturgeon fishery of South Carolina. Bears Bluff Labs, No. 47. 27 pp.

Lichter, J., H. Caron, T.S. Pasakarnis, S.L. Rodgers, T.S. Squiers Jr., and C.S. Todd. 2006. The ecological collapse and partial recovery of a freshwater tidal ecosystem. Northeastern Naturalist 13:153-178.

Longwell, A.C., S. Chang, A. Hebert, J. Hughes and D. Perry. 1992. Pollution and developmental abnormalities of Atlantic fishes. Environmental Biology of Fishes 35:1- 21.

Mac, M.J., and C.C. Edsall. 1991. Environmental contaminants and the reproductive success of lake trout in the Great Lakes: An epidemiological approach. Journal of Toxicology and Environmental Health 33:375-394.

Mangin, E. 1964. Croissance en Longueur de Trois Esturgeons d'Amerique du Nord: *Acipenser oxyrhynchus,* Mitchill, *Acipenser fulvescens*, Rafinesque, et *Acipenser brevirostris* LeSueur. Verh. Int. Ver. Limnology 15:968-974.

Mayfield RB, Cech JJ Jr. 2004. Temperature effects on green sturgeon bioenergetics. Trans Am Fish Soc 133:961–970

McCord, J.W., M.R. Collins, W.C. Post, and T.I.J. Smith. 2007. Attempts to Develop an Index of Abundance for Age-1 Atlantic Sturgeon in South Carolina, USA. American Fisheries Society Symposium 56:397-403.

Mohler, J.W. 2003. Culture Manual for the Atlantic sturgeon. U.S. Fish and Wildlife Service. Hadley, Massachusetts. 70 pp.

Morgan, R.P., V.J. Rasin and L.A. Noe. 1973. Effects of Suspended Sediments on the Development of Eggs and Larvae of Striped Bass and White Perch. Natural resources Institute, Chesapeake Biological Laboratory, U of Maryland, Center for Environmental and Estuarine Studies. 20 pp.

Moser, M.L. and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234.

Munro, J, R.E. Edwards, and A.W. Kahnle. 2007. Summary and synthesis. Pages 1-15 in J. Munro, D. Hatin, J.E. Hightower, K. McKown, K.J. Sulak, A.W. Kahnle, and F. Caron, eds. Anadromous sturgeons: habitats, threats, and management. American Fisheries Society Symposium 56. Bethesda, Maryland.

Murawski, S.A., and A.L. Pacheco. 1977. Biological and fisheries data on Atlantic sturgeon, *Acipenser oxyrhynchus* (Mitchill). National Marine Fisheries Service Technical Series Report 10:1-69.

Murdoch, P. S., J. S. Baron, and T. L. Miller. 2000. Potential effects of climate change on surface-water quality in North America. JAWRA Journal of the American Water Resources Association, 36: 347–366.

Musick, J.A., R.E. Jenkins, and N.B. Burkhead. 1994. Sturgeons, family Acipenseridae. Pages 183-190 in R.E. Jenkins and N.B. Burkhead, eds. Freshwater Fishes of Virginia. Bethesda, Maryland: American Fisheries Society.

NAST (National Assessment Synthesis Team). 2000. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Washington, D.C.: U.S. Global Change Research Program. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/1IntroA.pdf

Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (Acipenser oxyrinchus and A. brevirostrum) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.

Niklitschek E.J., and D.H. Secor. 2005. Modeling spatial and temporal variation of suitable nursery habitats for Atlantic sturgeon in the Chesapeake Bay. Estuarine, Coastal and Shelf Science 64:135-148.

Niklitschek, E.J., and D.H. Secor. 2010. Experimental and field evidence of behavioural habitat selection by juvenile Atlantic *Acipenser oxyrinchus oxyrinchus* and shortnose *Acipenser brevirostrum* sturgeons. Journal of Fish Biology 77(6):1293-1308.

NMFS, 1996. Status Review of shortnose sturgeon in the Androscoggin and Kennebec Rivers. Northeast Regional Office, National Marine Fisheries Service, unpublished report. 26 pp.

NMFS. 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.

NMFS NEFSC (Northeast Fisheries Science Center). 2011a. Summary of Discard Estimates for Atlantic Sturgeon. Draft working paper prepared by T. Miller and G. Shepard, Population Dynamics Branch. August 19, 2011.

NOAA. 1979. Testimony of Dr. Dadswell. May 14, 1979. Docket C/II-WP-77-01.

NRC 2010. Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Supplement 38 – Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3. Final Report. NUREG-1437, Supplement 38

NRC 2009. Biological Assessment to NMFS for Indian Point relicensing. Unpublished report transmitted to NMFS.

NRC 2010b. Revised Biological Assessment to NMFS for Indian Point relicensing. December 2010.

NRC 2011. Supplement to Biological Assessment to NMFS for Indian Point relicensing.

NYHS (New York Historical Society as cited by Dovel as Mitchell. S. 1811). 1809. Volume1. Collections of the New-York Historical Society for the year 1809.

NYDEC. 1982. State Pollution Discharge Elimination System Final Permit for Indian Point Nuclear Generating Station.

NYSDEC (New York State Department of Environmental Conservation). 2003. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2 Bowline 1 and 2 and IP2 and IP3 2 and 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties" (Hudson River Power Plants FEIS). June 25, 2003.

NYDEC. 2010. Letter from W. Adriance to D. Grey, Entergy. Denial of 401 WQC. April 2, 2010.

Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (Acipenser oxyrinchus and A. brevirostrum) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.

Oakley, N.C. 2003. Status of shortnose sturgeon, *Acipenser brevirostrum*, in the Neuse River, North Carolina. Master's thesis. North Carolina State University, Raleigh, North Carolina.

O'Herron, J.C., K.W. Able, and R.W. Hastings. 1993. Movements of shortnose sturgeon (*Acipenser brevirostrum)* in the Delaware River. Estuaries 16:235-240.

Palmer M.A., C.A. Reidy, C. Nilsson, M. Florke, J. Alcamo, P.S. Lake, and N. Bond. 2008. Climate change and the world's river basins: anticipating management options. Frontiers in Ecology and the Environment 6:81-89.

Parker E. 2007. Ontogeny and life history of shortnose sturgeon (*Acipenser brevirostrum* lesueur 1818): effects of latitudinal variation and water temperature. Ph.D. Dissertation. University of Massachusetts, Amherst. 62 pp.

Pekovitch, A.W. 1979. Distribution and some life history aspects of shortnose sturgeon (*Acipenser brevirostrum)* in the upper Hudson River Estuary. Hazleton Environmental Sciences Corporation. 67 pp.

Pikitch, E.K., P. Doukakis, L. Lauck, P. Chakrabarty and D.L. Erickson. 2005. Status, trends and management of sturgeon and paddlefish fisheries. Fish and Fisheries 6:233-265.

Pisces Conservation Ltd. 2008. The status of fish populations and ecology of the Hudson River. Prepared by R.M. Seaby and P.A. Henderson. http://www.riverkeeper.org/wp-content/uploads/2009/06/Status-of-Fish-in-the-Hudson-Pisces.pdf

Pyzik, L., J. Caddick, and P. Marx. 2004. Chesapeake Bay: introduction to an ecosystem. Chesapeake Bay Program, EPA Publication 903-R-04-003. Annapolis, Maryland.

Rogers, S. G., and W. Weber. 1994. Occurrence of shortnose sturgeon (Acipenser brevirostrum) in the Ogeechee-Canoochee river system, Georgia during the summer of 1993.

Final Report of the United States Army to the Nature Conservancy of Georgia.

Rogers, S.G., and W. Weber. 1995a. Movements of shortnose sturgeon in the Altamaha River system, Georgia. Contributions Series #57. Coastal Resources Division, Georgia Department of Natural Resources, Brunswick, Georgia.

Rogers, S.G., and W. Weber. 1995b. Status and restoration of Atlantic and shortnose sturgeons in Georgia. Final Report to the National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.

Ruelle, R., and K.D. Keenlyne. 1993. Contaminants in Missouri River pallid sturgeon. Bull. Environ. Contam. Toxicol. 50: 898-906.

Ruelle, R. and C. Henry. 1994. Life history observations and contaminant evaluation of pallid sturgeon. Final Report U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, South Dakota Field Office, 420 South Garfield Avenue, Suite 400, Pierre, South Dakota 57501-5408.

Savoy, T. 2007. Prey eaten by Atlantic sturgeon in Connecticut waters. American Fisheries Society Symposium 56:157-165.

Savoy, T., and D. Pacileo. 2003. Movements and habitats of subadult Atlantic sturgeon in Connecticut waters. Transactions of the American Fisheries Society 131:1-8.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184. 966 pp.

Scott, W.B., and M.G. Scott. 1988. Atlantic Fishes of Canada. University of Toronto Press, Toronto, Canada.

Secor, D.H., and J.R. Waldman. 1999. Historical abundance of Delaware Bay Atlantic sturgeon and potential rate of recovery. American Fisheries Society Symposium 23:203-216.

Secor, D.H. 2002. Atlantic sturgeon fisheries and stock abundances during the late nineteenth century. American Fisheries Society Symposium 28:89-98.

Sherk, J.A. J.M. O'Connor and D.A. Neumann. 1975. Effects of suspended and deposited sediments on estuarine environments. *In*: Estuarine Research Vol. II. Geology and Engineering. L.E. Cronin (editor). New York: Academic Press, Inc.

Shirey, C.A., C.C. Martin, and E.J. Stetzar. 1999. Atlantic sturgeon abundance and movement in the lower Delaware River. Final Report. NOAA Project No. AGC-9N, Grant No. A86FAO315. Dover: Delaware Division of Fish and Wildlife.

Skjeveland, Jorgen E., Stuart A. Welsh, Michael F. Mangold, Sheila M. Eyler, and Seaberry

Nachbar. 2000. A Report of Investigations and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake bay (1996-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 44 pp.

Smith, Hugh M. and Barton A. Bean. 1899. List of fishes known to inhabit the waters of the District of Columbia and vicinity. Prepared for the United States Fish Commission. Washington Government Printing Office, Washington, D.C.

Smith, T.I.J. 1985. The fishery, biology, and management of Atlantic sturgeon, *Acipenser oxyrhynchus*, in North America. Environmental Biology of Fishes 14(1):61-72.

Smith, T.I.J., and J.P. Clugston. 1997. Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. Environmental Biology of Fishes 48:335-346.

Smith, T.I.J., E.K. Dingley, and E.E. Marchette. 1980. Induced spawning and culture of Atlantic sturgeon. Progressive Fish Culturist 42:147-151.

Smith, T.I.J., D.E. Marchette, and R.A. Smiley. 1982. Life history, ecology, culture and management of Atlantic sturgeon, *Acipenser oxyrhynchus oxyrhynchus,* Mitchill, in South Carolina. South Carolina Wildlife Marine Resources Department. Final Report to U.S. Fish and Wildlife Service Project AFS-9. 75 pp.

Snyder, D.E. 1988. Description and identification of shortnose and Atlantic sturgeon larvae. American Fisheries Society Symposium 5:7-30.

Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. U.S. Fish and Wildlife Service, Charles City, Virginia.

Squiers, T. 2004. State of Maine 2004 Atlantic sturgeon compliance report to the Atlantic States Marine Fisheries Commission. Washington, D.C. December 22, 2004.

Squiers, T.S., and M. Smith. 1979. Distribution and abundance of shortnose and Atlantic sturgeon in the Kennebec River estuary. Maine Department of Marine Resources, Completion Report, Project AFC-19. Augusta, Maine.

Squiers, T., L. Flagg, and M. Smith. 1982. American shad enhancement and status of sturgeon stocks in selected Maine waters. Completion report, Project AFC-20.

Squiers, T. And M. Robillard. 1997. Preliminary report on the location of overwintering sites for shortnose sturgeon in the estuarial complex of the Kennebec River during the winter of 1996/1997. Unpublished report, submitted to the Maine Department of Transportation.

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the Northeast United States. North American Journal of Fisheries Management 24:171-183.

Stevenson, J.T., and D.H. Secor. 1999. Age determination and growth of Hudson River Atlantic sturgeon, *Acipenser oxyrinchus*. Fishery Bulletin 97:153-166.

Swanson, C., D. Crowley, Y. Kim, N. Cohn, and D. Mendelsohn. 2011a. Part 2 of Response to the NYSDEC Staff Review of the 2010 Field Program and Modeling Analyis of the Cooling Water Discharge from the Indian Point Energy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. ML 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Swanson, C., D. Mendelsohn, N. Cohn, D. Crowley, Y. Kim, L Decker, and L Miller. 2011 b. Final Report: 2010 Field Program and Modeling Analysis of the Cooling Water Discharge from the Indian Point Entergy Center. Prepared for Indian Point Energy Center, Buchanan, New York. ADAMS Accession No. **ML** 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

Sweka, J.A., J. Mohler, M.J. Millard, T. Kehler, A. Kahnle, K. Hattala, G. Kenney, and A. Higgs. 2007. Juvenile Atlantic sturgeon habitat use in Newburgh and Haverstraw bays of the Hudson River: Implications for population monitoring. North American Journal of Fisheries Management 27:1058-1067.

Taub, S.H. 1990. Interstate fishery management plan for Atlantic sturgeon. Fisheries Management Report No. 17. Atlantic States Marine Fisheries Commission, Washington, D.C. 73 pp.

Taubert, B.D. 1980b. Biology of shortnose sturgeon (Acipenser brevirostrum) in the Holyoke Pool, Connecticut River, Massachusetts. Ph.D. Thesis, University of Massachusetts, Amherst, 136 p.

Taubert, B.D., and M.J. Dadswell. 1980. Description of some larval shortnose sturgeon (Acipenser brevirostrum) from the Holyoke Pool, Connecticut River, Massachusetts, USA, and the Saint John River, New Brunswick, Canada. Canadian Journal of Zoology 58:1125-1128.

Uhler, P.R. and O. Lugger. 1876. List of fishes of Maryland. Rept. Comm. Fish. MD. 1876: 67-176.

USDOI (United States Department of Interior). 1973. Threatened wildlife of the United States. Shortnose sturgeon. Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, Washington, D.C. Resource Publication 114 (Revised Resource Publication 34).

Van den Avyle, M.J. 1984. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Atlantic): Atlantic sturgeon. U.S. Fish and Wildlife Service Biological Services Program FWS/OBS 82(11.25). 17 pp.

Van Eenennaam, J.P., and S.I. Doroshov. 1998. Effects of age and body size on gonadal development of Atlantic sturgeon. Journal of Fish Biology 53:624-637.

Van Eenennaam, J.P., S.I. Doroshov, G.P. Moberg, J.G. Watson, D.S. Moore, and J. Linares. 1996. Reproductive conditions of the Atlantic sturgeon (*Acipenser oxyrhynchus*) in the Hudson River. Estuaries 19:769-777.

Varanasi, U. 1992. Chemical contaminants and their effects on living marine resources. pp. 59-71. in: R. H. Stroud (ed.) Stemming the Tide of Coastqal Fish Habitat Loss. Proceedings of the Symposium on Conservation of Fish Habitat, Baltimore, Maryland. Marine Recreational Fisheries Number 14. National Coalition for Marine Conservation, Inc., Savannah Georgia.

Vinyard, L. and W.J. O'Brien. 1976. Effects of light and turbidity on the reactive distance of bluegill (*Lepomis macrochirus*) J. Fish. Res. Board Can. 33: 2845-2849.

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidea. Pages 24-60 in Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(Part III). xxi + 630 pp.

Von Westernhagen, H., H. Rosenthal, V. Dethlefsen, W. Ernst, U. Harms, and P.D. Hansen. 1981. Bioaccumulating substances and reproductive success in Baltic flounder Platichthys flesus. Aquatic Toxicology 1:85-99.

Wehrell, S. 2005. A survey of the groundfish caught by the summer trawl fishery in Minas Basin and Scots Bay. Honours Thesis. Acadia University, Wolfville, Canada.

Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L. and J. Waldman. 2005. Range-wide population structure of shortnose sturgeon Acipenser brevirostrum based on sequence analysis of mitochondrial DNA control region. Estuaries 28:406-21.

Waldman, J.R., J.T. Hart, and I.I. Wirgin. 1996. Stock composition of the New York Bight Atlantic sturgeon fishery based on analysis of mitochondrial DNA. Transactions of the American Fisheries Society 125:364-371.

Waldman JR, Grunwald C, Stabile J, Wirgin I. 2002. Impacts of life history and biogeography on genetic stock structure in Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, Gulf sturgeon *A. oxyrinchus desotoi*, and shortnose sturgeon, *A.brevirostrum.* J Appl Ichthyol 18:509-518

Walsh, M.G., M.B. Bain, T. Squires, J.R. Walman, and Isaac Wirgin. 2001. Morphological and genetic variation among shortnose sturgeon Acipenser brevirostrum from adjacent and distant rivers. Estuaries Vol. 24, No. 1, p. 41-48. February 2001.

Waters, Thomas F. 1995. Sediment in Streams. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, MD. Pages 95-96.

Weber, W. 1996. Population size and habitat use of shortnose sturgeon, Acipenser brevirostrum, in the Ogeechee River sytem, Georgia. Masters Thesis, University of Georgia, Athens, Georgia.

Welsh, Stuart A., Michael F. Mangold, Jorgen E. Skjeveland, and Albert J. Spells. 2002. Distribution and Movement of Shortnose Sturgeon (*Acipenser brevirostrum*) in the Chesapeake Bay. Estuaries Vol. 25 No. 1: 101-104.

Wilber, Dara H. and Douglas C. Clarke. 2001. Biological Effects of Suspended Sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Woodland, R. J. 2005. Age, growth, and recruitment of Hudson River shortnose sturgeon (Acipenser brevirostrum). Master's thesis. University of Maryland, College Park.

Wirgin, I., and T. King. 2011. Mixed stock analysis of Atlantic sturgeon from coastal locales and a non-spawning river. Presented at February 2011 Atlantic and shortnose sturgeon workshop.

Wirgin, I., J. Grunwald, J. Stabile, and J. Waldman. 2007. Genetic evidence for relict Atlantic sturgeon stocks along the Mid-Atlantic coast of the USA. North American Journal of Fisheries Management 27:1214-1229.

Wirgin, I., L. Maceda, J.R. Waldman, S. Wehrell, M. Dadswell, and T. King. In Prep. Stock origin of migratory Atlantic sturgeon in the Minas Basin, Inner Bay of Fundy, Canada, determined by microsatellite and mitochondrial DNA analyses.

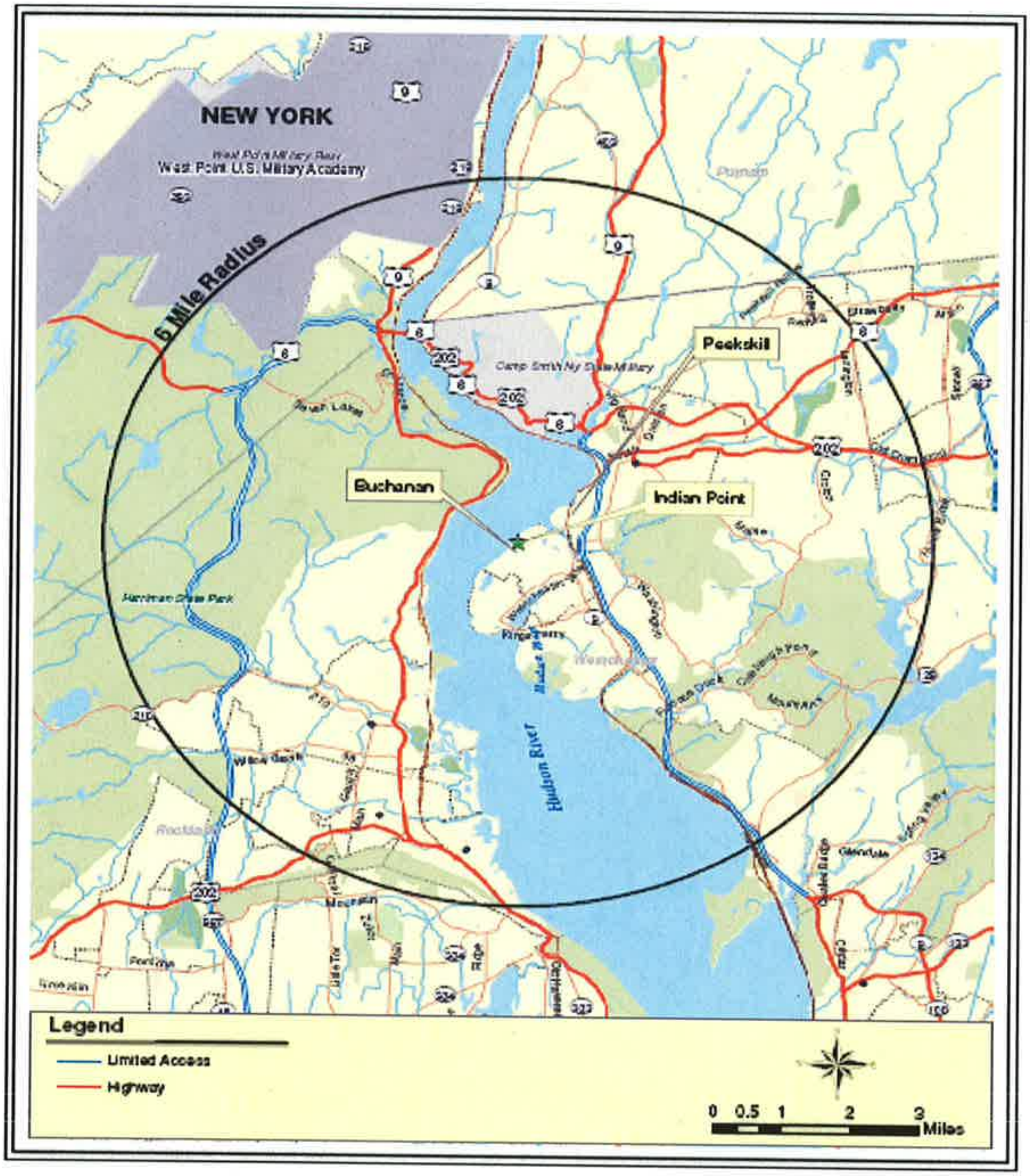
Woodland, R.J. and D. H. Secor. 2007. Year-class strength and recovery of endangered shortnose sturgeon in the Hudson River, New York. Transaction of the American Fisheries Society 136:72-81.

Young, J.R., T.B. Hoff, W.P. Dey, and J.G. Hoff. 1988. Management recommendations for a Hudson River Atlantic sturgeon fishery based on an age-structured population model. Pages 353-365 in C.L. Smith, ed. Fisheries Research in the Hudson River. Albany: State University of New York Press.

Ziegeweid, J.R., C.A. Jennings, and D.L. Peterson. 2008a. Thermal maxima for juvenile shortnose sturgeon acclimated to different temperatures. Environmental Biology of Fish 3: 299-307.

Ziegeweid, J.R., C.A. Jennings, D.L. Peterson and M.C. Black. 2008b. Effects of salinity, temperature, and weight on the survival of young-of-year shortnose sturgeon. Transactions of the American Fisheries Society 137:1490-1499.

Figure 1

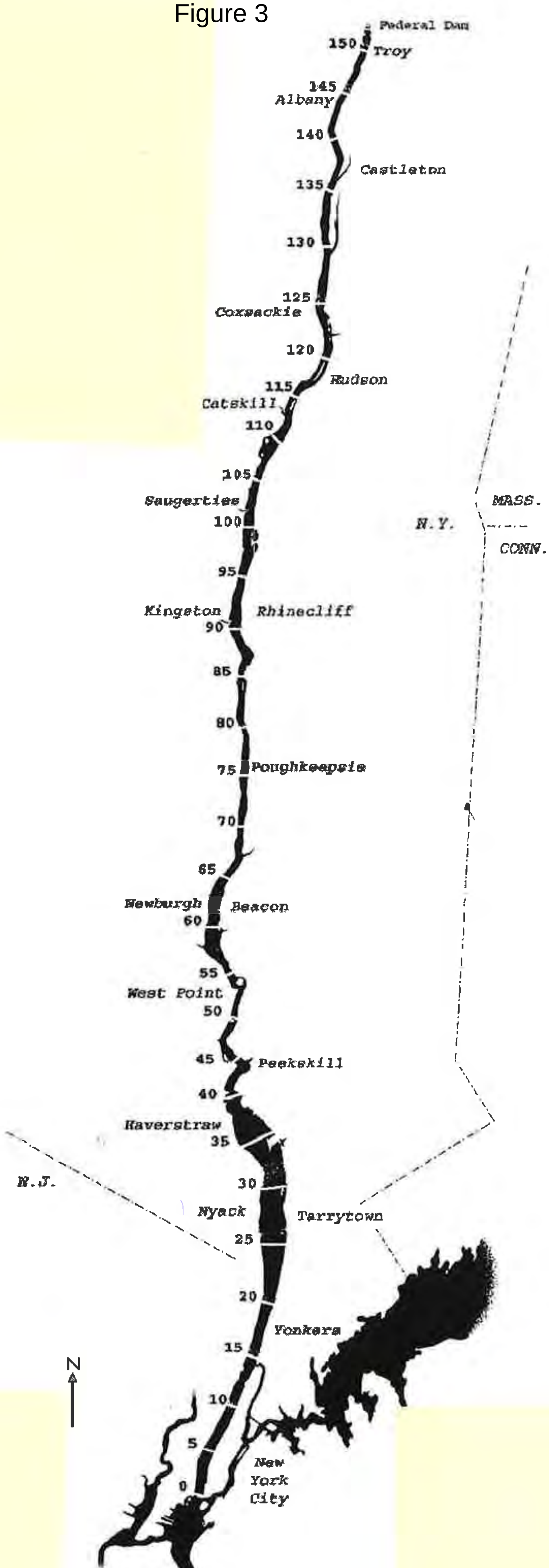


Location of Indian Point Generating Station

Figure 2

MASSACHUSETTS
CONNECTICUT
NEW YORK
NEW JERSEY
PENNSYLVANIA
50 Mile Radius
Kingston
Poughkeepsie–Newburgh
Indian Point
Middletown
Danbury
Waterbury
Hartford
New Haven
Bridgeport–Stamford
New York–Newark
North Atlantic Ocean
Legend
Limited Access
Highway
Major Road
State
County
Airport
2000 Population - Urban Areas
719 - 1,008,509
1,008,510 - 8,209,353
8,209,354 - 17,340,042
0 3 6 12 18 24 Miles

Figure 3



Hudson River Miles

APPENDIX II

Incident Report Sturgeon Take – Indian Point

Photographs should be taken and the following information should be collected from all sturgeon (alive and dead) found in association with the Indian Point intakes. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name:____
Reporter's full name:____

Species Identification :____

Site of Impingement (Unit 2 or 3, CWS or DWS, Bay #, etc.):________________________________

Date animal observed:________________ Time animal observed: ________________________
Date animal collected:________________ Time animal collected:_________________________

Environmental conditions at time of observation (i.e., tidal stage, weather):
____
____

Date and time of last inspection of intakes:_____________________________________
Water temperature (°C) at site and time of observation:_________________________
Number of pumps operating at time of observation:___________________________________
Average percent of power generating capacity achieved per unit at time of observation:________
Average percent of power generating capacity achieved per unit over the 48 hours previous to observation:____

Sturgeon Information:
Species ____________________________________

Fork length (or total length) _______________________ Weight ________________________

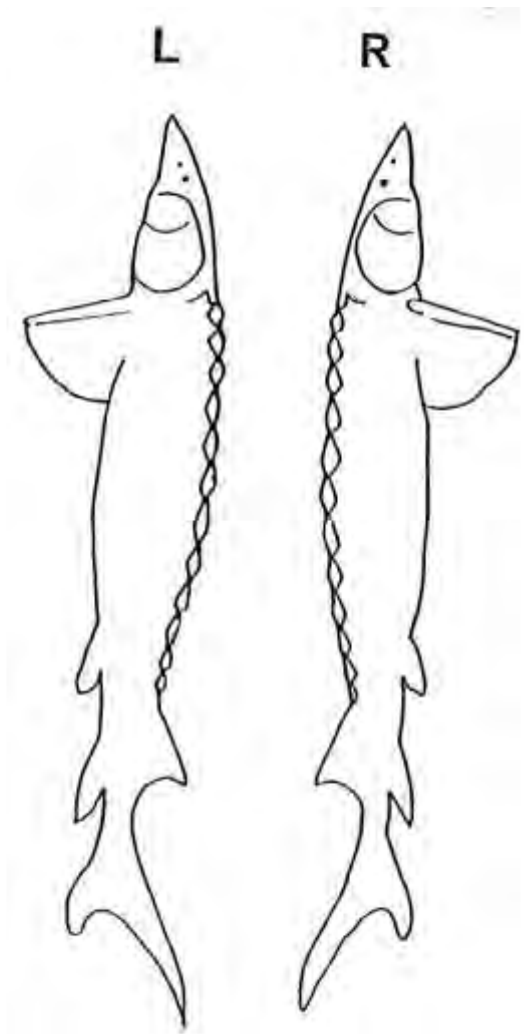
Condition of specimen/description of animal
____
____
____
____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish tagged: YES / NO *Please record all tag numbers.* Tag # _________________

Photograph attached: YES / NO
(please label *species, date, geographic site* and *vessel name* on back of photograph)

Appendix II, continued

Draw wounds, abnormalities, tag locations on diagram and briefly describe below



Description of fish condition:

APPENDIX III

STURGEON SALVAGE FORM

For use in documenting dead sturgeon in the wild under ESA permit no. 1614 (version 05-16-2012)

INVESTIGATORS'S CONTACT INFORMATION

Name: First ____________ Last ____________

Agency Affiliation ____________ Email ____________

Address ______________________________

____

Area code/Phone number ______________________________

UNIQUE IDENTIFIER (Assigned by NMFS)

DATE REPORTED:
Month ☐☐ Day☐☐ Year 20☐☐

DATE EXAMINED:
Month ☐☐ Day☐☐ Year 20☐☐

SPECIES: (check one)
- ☐ shortnose sturgeon
- ☐ Atlantic sturgeon
- ☐ Unidentified *Acipenser* species

Check "Unidentified" if uncertain .
See reverse side of this form for aid in identification.

LOCATION FOUND: ☐Offshore (Atlantic or Gulf beach) ☐Inshore (bay, river, sound, inlet, etc)

River/Body of Water____________ City____________ State ____

Descriptive location (be specific)______________________________

____

____

Latitude ____________N (Dec. Degrees) Longitude ____________ W (Dec. Degrees)

CARCASS CONDITION at time examined: (check one)
- ☐ 1 = Fresh dead
- ☐ 2 = Moderately decomposed
- ☐ 3 = Severely decomposed
- ☐ 4 = Dried carcass
- ☐ 5 = Skeletal, scutes & cartilage

SEX:
- ☐ Undetermined
- ☐ Female ☐ Male

How was sex determined?
- ☐ Necropsy
- ☐ Eggs/milt present when pressed
- ☐ Borescope

MEASUREMENTS: **Circle unit**

Fork length ________ cm / in

Total length ________ cm / in

Length ☐ actual ☐ estimate

Mouth width (inside lips, see reverse side) ________ cm / in

Interorbital width (see reverse side) ________ cm / in

Weight ☐ actual ☐ estimate ________ kg / lb

TAGS PRESENT? Examined for external tags including fin clips? ☐ Yes ☐ No Scanned for PIT tags? ☐ Yes ☐ No

Tag #	Tag Type	Location of tag on carcass
____________	____________	____________
____________	____________	____________

CARCASS DISPOSITION: (check one or more)
- ☐1 = Left where found
- ☐2 = Buried
- ☐3 = Collected for necropsy/salvage
- ☐4 = Frozen for later examination
- ☐5 = Other (describe) ____________

Carcass Necropsied?
☐Yes ☐No

Date Necropsied:____________

Necropsy Lead:

____

PHOTODOCUMENTATION:
Photos/vide taken? ☐ Yes ☐ No

Disposition of Photos/Video:____________

____

____

SAMPLES COLLECTED? ☐ Yes ☐ No

Sample	How preserved	Disposition (person, affiliation, use)
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________

Comments:

____

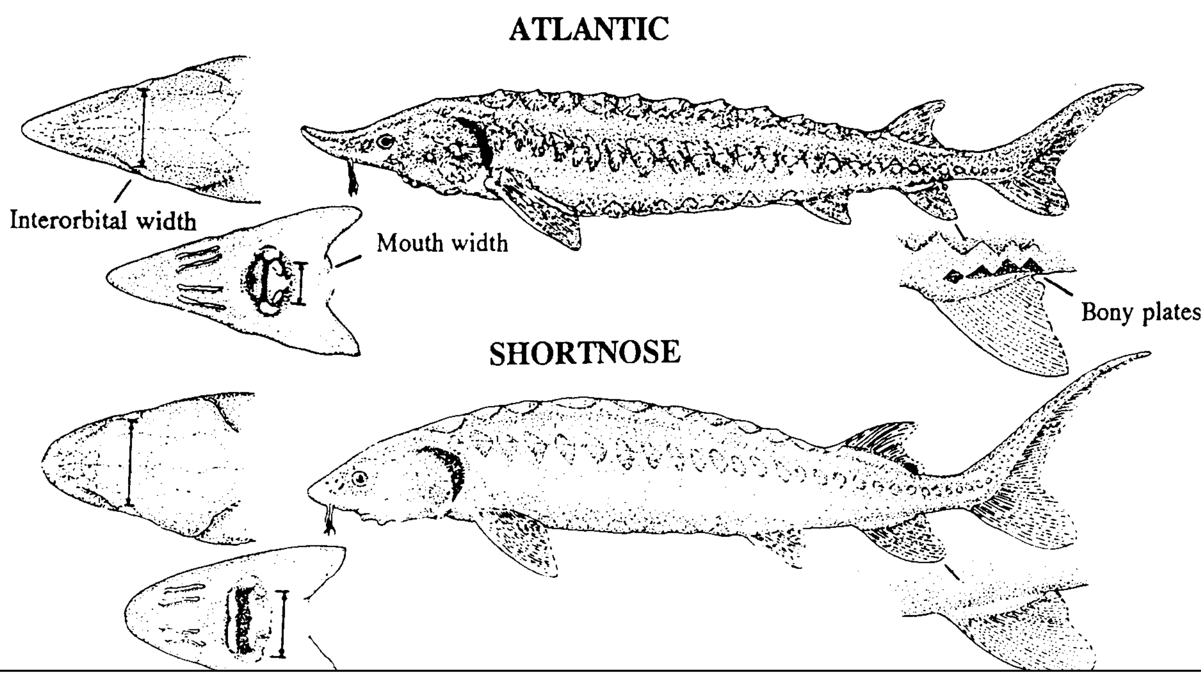
____

____

Distinguishing Characteristics of Atlantic and Shortnose Sturgeon (version 07-20-2009)

Characteristic	Atlantic Sturgeon, *Acipenser oxyrinchus*	Shortnose Sturgeon, *Acipenser brevirostrum*
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004



Describe any wounds / abnormalities (note tar or oil, gear or debris entanglement, propeller damage, etc.). **Please note if no wounds / abnormalities are found.**

____

____

____

____

____

Data Access Policy: Upon written request, information submitted to National Marine Fisheries Service (NOAA Fisheries) on this form will be released to the requestor provided that the requestor credit the collector of the information and NOAA Fisheries. NOAA Fisheries will notify the collector that these data have been requested and the intent of their use.

Submit completed forms (within 30 days of date of investigation) to: **Northeast Region Contacts** – Shortnose Sturgeon Recovery Coordinator (Jessica Pruden, Jessica.Pruden@noaa.gov, 978-282-8482) or Atlantic Sturgeon Recovery Coordinator (Lynn Lankshear, Lynn.Lankshear@noaa.gov, 978-282-8473); **Southeast Region Contacts**- Shortnose Sturgeon Recovery Coordinator (Stephania Bolden, Stephania.Bolden@noaa.gov, 727-824-5312) or Atlantic Sturgeon Recovery Coordinator (Kelly Shotts, Kelly.Shotts@noaa.gov, 727-551-5603).

APPENDIX IV

Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

1. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

Sending of Sample

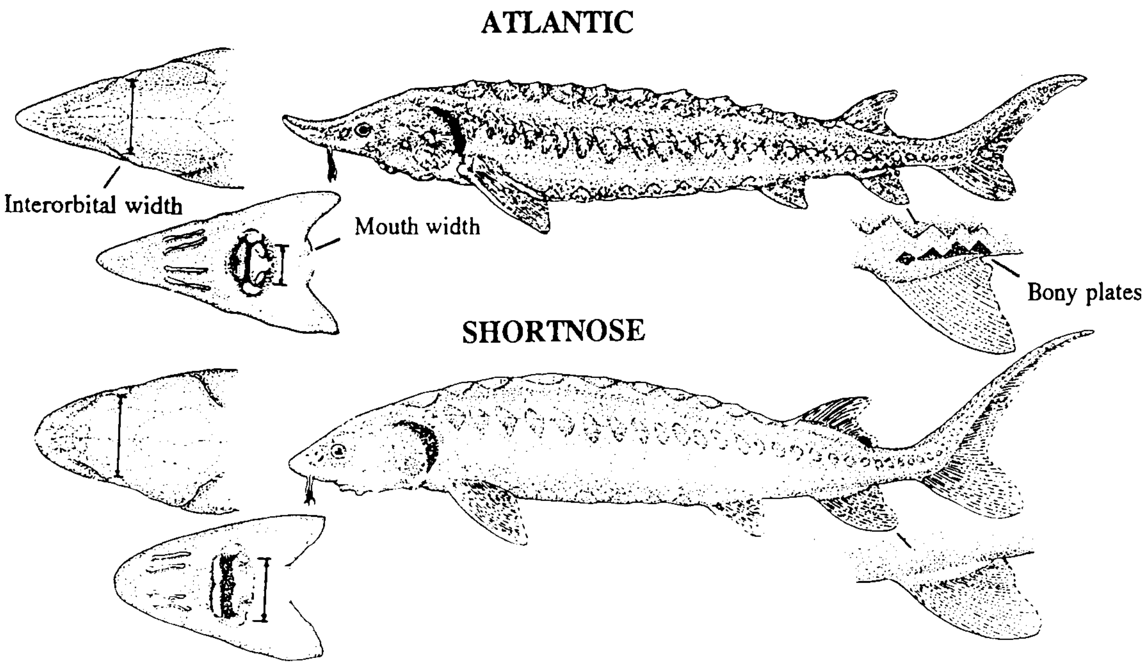
1. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547

   a. Prior to sending the sample, contact Russ Bohl at NMFS Northeast Regional Office (978-282-8493) to report that a sample is being sent and to discuss proper shipping procedures.

APPENDIX V

Identification Key for Sturgeon Found in Northeast U.S. Waters



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

Characteristic	**Atlantic Sturgeon, *Acipenser oxyrinchus***	**Shortnose Sturgeon, *Acipenser brevirostrum***
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004

Riverkeeper Amended Contention RK-EC-8A:

Attachment 7

BADB received
8/21/2012
10:AM

As of: August 21, 2012
Received: August 20, 2012
Status: Pending_Post
Tracking No. 810e6342
Comments Due: August 20, 2012
Submission Type: Web

PUBLIC SUBMISSION

Docket: NRC-2008-0672
Environmental Impact Statement; Availability, etc.: Indian Point Nuclear Generating Unit Nos. 2 and 3, Buchanan, NY; License Renewal and Public Meeting

Comment On: NRC-2008-0672-0013
Entergy Nuclear Operations, Inc; Indian Point Nuclear Generating, Units 2 and 3; Availability of Environmental Impact Statement

Document: NRC-2008-0672-DRAFT-0011
Comment on FR Doc # 2012-16548

Submitter Information

7/6/2012
77 FR 40091

6

Name: Deborah Brancato
Address:
20 Secor Road
Ossining, NY, 10562
Submitter's Representative: Deborah Brancato
Organization: Riverkeeper

General Comment

Please accept the attached comments on behalf of Riverkeeper, Inc. on the U.S. Nuclear Regulatory Commission Staff's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment.

Respectfully submitted,

Deborah Brancato, Esq.

Attachments

2012.08.20.Riverkeeper Comments on NRC Staff Indian Point Draft FSEIS Supplement

SUNSI Review Complete
Template = ADM-013

E-RIDS= ADM-03
add = M. Wentzel (MJW2)

RIVERKEEPER.
NY's clean water advocate

August 20, 2012

SUBMITTED ELECTRONICALLY

Chief, Rules, Announcements, and Directives Branch
Division of Administrative Services
Office of Administration
Mail Stop: TWB-05-B01M
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: *Docket ID NRC-2008-0672* – Riverkeeper, Inc.'s Comments on the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50–247 and 50–286 (June 2012)

Dear Rules, Announcements, and Directives Branch Chief:

Riverkeeper, Inc. ("Riverkeeper") hereby respectfully submits the following comments on the U.S. Nuclear Regulatory Commission Staff's ("NRC Staff") Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment (hereinafter referred to as "Draft FSEIS Supplement"). Notice of availability of, and opportunity to comment on, the Draft FSEIS Supplement was published on June 26, 2012.[1]

The NRC Staff initially issued a final supplemental environmental impact statement relating to the proposed license renewal of Indian Point in December 2010.[2] Based upon purported newly available information, the NRC Staff issued the above-referenced draft supplement to this final

[1] *See* Letter from David J. Wrona (NRC) to U.S. Environmental Protection Agency Office of Federal Activities NEPA Compliance Division EIS Filing Section, Re: Notice of Availability of Draft Supplement to Final Plant Specific Supplement 38 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 (June 26, 2012), ADAMS Accession No. ML12159A495 (indicating a comment period extending to August 20, 2012).

[2] *See* Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 - Final Report, Main Report and Comment Responses (NUREG-1437, Supplement 38, Volumes 1-3), *available at*, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/supplement38/ (last visited Aug. 20, 2012).

report.[3] In particular, NRC Staff's Draft FSEIS Supplement includes "corrections to impingement and entrainment data presented in the FSEIS and revised conclusions regarding thermal impacts" in light of new "thermal plume studies"; NRC Staff's draft supplement also provides "an update of the status of the NRC's consultation under section 7 of the Endangered Species Act with the National Marine Fisheries Service [NMFS] regarding shortnose sturgeon . . . and Atlantic sturgeon."[4]

NRC Staff's Revised Analysis of Impingement and Entrainment Impacts at Indian Point

NRC Staff's Draft FSEIS Supplement includes a revised assessment of impingement and entrainment impacts based upon new information obtained from Entergy about impingement and entrainment field data units of measure.[5] However, NRC Staff's new analysis does not meaningfully alter the ultimate conclusion that the operation of Indian Point has, and will continue to have, a profoundly negative impact upon the aquatic ecology of the Hudson River.

Riverkeeper's expert biologist consultants at Pisces Conservation Ltd. ("Pisces"), who reviewed and commented upon NRC Staff's initial assessment of impingement and entrainment impacts at Indian Point,[6] have now also reviewed NRC Staff's new Draft FSEIS Supplement. Pisces has prepared a response to NRC Staff's new supplement, which is provided in support of the instant comments as Attachment A.[7] Pisces recognizes that Entergy's presentation of the data with incorrect units caused confusion and errors in the calculation of the number of organisms impinged and entrained at Indian Point.[8] However, Pisces points out that for most species, "the error in units cancelled themselves out," resulting in no change in NRC Staff's conclusions about the level of impact from impingement and entrainment at Indian Point on such species.[9] Pisces indicates that the only species greatly affected by NRC Staff's consideration of Entergy's "corrected" data was spottail shiner.[10] Pisces explains that even with this change, eight critical fish species continue to have a high strength of connection to the effects of Indian Point, and that Indian Point continues to have a "MODERATE" or "LARGE" impact on several fish species exhibiting this high level of connection.[11] Overall, NRC Staff's revised assessment did not meaningfully change the outcome of NRC Staff's analysis, or NRC Staff's ultimate conclusions about impingement and entrainment impacts caused by Indian Point.

[3] *See* Draft FSEIS Supplement at iii, ix, 1-2.

[4] *See id.*

[5] *See id.* at ix, 3-16.

[6] *See* Comment of Phillip Musegaas, Victor M. Tafur, and Deborah Brancato on Behalf of Riverkeeper, Inc. on Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Regarding Indian Point, Units 2 & 3 (March 18, 2009), ADAMS Accession No. ML090860983, at 5-9 (hereinafter "Riverkeeper Comments on Indian Point Dec. 2008 DSEIS").

[7] Pisces Conservation, Ltd, "Some notes on the Generic Environmental Impact Statement for License Renewal of Nuclear Plants - Supplement 38" (August 20, 2012) ("Attachment A – Pisces Memo").

[8] Attachment A – Pisces Memo at 1-2.

[9] *Id.*

[10] *Id.* at 2.

[11] *Id.*

Importantly, Pisces' original review of NRC Staff's draft assessment of entrainment and impingement at Indian Point revealed various deficiencies and inadequacies in the analysis.[12] As a result of such deficiencies, Pisces previously explained that the actual impact of Indian Point of various fish species was likely underestimated by NRC Staff.[13] NRC Staff's December 2010 FSEIS did not address Pisces' concerns or adequately recognize the devastating level of impact associated with the operation of Indian Point.[14] Likewise, NRC Staff's Draft FSEIS Supplement contains no analysis that addresses Pisces' original concerns. Nothing in NRC Staff's revised assessment alters the criticism articulated by Pisces relating to the flawed methodology employed by NRC Staff to determine impingement and entrainment impacts caused by Indian Point. Thus, for the reasons articulated in Pisces' original report concerning NRC Staff's environmental impact statement for the relicensing of Indian Point, NRC Staff's assessment remains fundamentally flawed and continues to misjudge the severity of impingement and entrainment at the plant.[15]

Indeed, the continued operation of Indian Point as proposed by Entergy, i.e., with the ongoing use of a once-through-cooling water intake structure, will result in significant impacts on an already stressed ecosystem.[16] This is simply not reflected in NRC Staff's Draft FSEIS

---

[12] *See* Riverkeeper Comments on Indian Point Dec. 2008 DSEIS, *supra* Note 6, at 5-9, and Exhibit A (P. A. Henderson & R. M. H. Seaby (Pisces Conservation Ltd), Comments relating to the Indian Point NRC draft EIS on the Cooling System (March 2009), at 1-9).

[13] *Id.*

[14] *See* Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 - Final Report, Main Report and Comment Responses (NUREG-1437, Supplement 38, Volume 1, at § 4.1.

[15] *See* Riverkeeper Comments on Indian Point Dec. 2008 DSEIS, *supra* Note 6, at 5-9, and Exhibit A (P. A. Henderson & R. M. H. Seaby (Pisces Conservation Ltd), Comments relating to the Indian Point NRC draft EIS on the Cooling System (March 2009), at 1-9).

[16] *See* Riverkeeper Comments on Indian Point Dec. 2008 DSEIS, *supra* Note 6 at 5-9, Exhibit A. The once-through cooling water system employed at Indian Point has a profound impact upon fish in the Hudson River. *See generally* Entrainment, Impingement and Thermal Impacts at Indian Point Nuclear Power Station, Pisces Conservation Ltd., November 2007, *available at*, http://www.riverkeeper.org/wp-content/uploads/2010/03/1397-PH-Henderson-Attachment-3-Expert-Report-Cont-EC-1.pdf, at 44; *see id.* at 4 ("Notably, "[t]he species for which entrainment mortality has been quantified form only a very small proportion of the total species present in the estuary. As was noted in the FEIS (page 53): '*Finally, although impingement and entrainment mortality is measured, it is typically measured only for several of the 140 species of fishes found in the Hudson. Information about the impact on the full suite of aquatic organisms is limited.*' The impact on other species is un-quantified and may be significant.") (emphasis in original); NYSDEC Fact Sheet, NY SPDES Draft Permit Renewal with Modification, Indian Point Electric Generating Station (Buchanan, NY – November 2003), at 2, Attachment B, page 1, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf ("Each year Indian Point Units 2 and 3. . . cause the mortality of more than a billion fish from entrainment of various life stages of fishes through the plant and impingement of fishes on intake screens. . . . Thus, current losses of various life stages of fishes are substantial."); NYSDEC Hudson River Power Plants FEIS (June 25, 2003), at 2-3, *available at* http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP1.pdf. DEC has characterized the destructive impacts associated with the operation of once-through cooling water intake structures as "comparable to habitat degradation; the entire natural community is impacted. . . . [I]mpingement and entrainment and warming of the water impact the entire community of organisms that inhabit the water column." NYSDEC Hudson River Power Plants FEIS (June 25, 2003), Public Comment Summary at 53-54, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP5.pdf (hereinafter "NYSDEC Power Plants FEIS

Supplement -- NRC Staff unfailingly refuses to recognize the reality of the situation, and ascribe a realistic and accurate level of impact of entrainment and impingement on the aquatic ecology of the Hudson River. Notably, NRC Staff is content to review Entergy's proposal to operate Indian Point for an additional 20 years in a vacuum – that is, without adequately assessing Entergy's proposal to install and implement cylindrical wedgewire screens to purportedly reduce entrainment and impingement impacts, even though doing so will result in additional negative impacts to the aquatic ecology of the Hudson River, such as impacts to the river bottom.

In addition, NRC Staff's Draft FSEIS Supplement fails to address the fact that NRC Staff continues to rely on old data.[17] That is, all NRC Staff has done in the Draft FSEIS supplement is correct certain calculation errors with respect to decades-old data that is not necessarily reflective of current conditions, and does not take into account negative changes to the status of fish populations in the Hudson River that have occurred over the years.[18] This runs afoul of Council

---

Comment Summary"). Nearly 40 years of such degradation resulting from the use of once-through cooling at Indian Point has resulted in serious long-term impacts. Evidence indicates an increasingly unstable ecosystem and long-term declines for several signature Hudson River fish species. A Riverkeeper report released in May 2008, revealed that many Hudson River fish are in serious long-term decline. *See* The Status of Fish Populations and the Ecology of the Hudson, Pisces Conservation Ltd., April 2008, *available at*, http://www.riverkeeper.org/wp-content/uploads/2009/06/Status-of-Fish-in-the-Hudson-Pisces.pdf (hereinafter "Pisces 2008 Status of Hudson River Fish Report") (analyzing 13 "key" species of the Hudson River, and finding that 10 such species are in decline); *see also* NYSDEC Power Plants FEIS Comment Summary at 57 ("Several species of fish in the Hudson River estuary, such as American shad, white perch, Atlantic tomcod and rainbow smelt, have shown trends of declining abundance."). As DEC has stated, such "[d]eclines in the abundances of several species and changes in species composition raises concerns and questions regarding the health of the River's fish community." NYSDEC Power Plants FEIS Comment Summary at 58. With, by far, the largest water intake on the Hudson estuary, slaughtering hundreds of millions, and possibly over a billion aquatic organisms every year, the once-through cooling water intake structure at Indian Point has undoubtedly contributed to such decline, destabilization, and loss of aquatic resources. *See, e.g.*, Pisces 2008 Status of Fish Report at 37-38 ("The impact of Indian Point is the largest of several impacts from once-through cooling on the Hudson. When all the power plants are considered, the impact is large... 'Tens- to hundreds-of-millions of eggs, larvae, and juvenile fishes of several species are killed per year for once-through users. The cumulative impact of multiple facilities substantially reduces the young-of-year (YOY) population for the entire river.' ... in some years these effects have been very large ... between 33 – 79% reductions in Young of Year population.... Even if the power companies are not the sole cause of degradation of the Hudson River fish community, the loss of such high proportions of the fish populations must be important." (quoting NYSDEC Water Quality 2006 Report)); *see also* NYSDEC Power Plants FEIS Comment Summary at 58 (expressly recognizing that "[t]he millions of fish that are killed by power plants each year represent a significant mortality and are yet another stress on the River's fish community" that "must be taken into account when assessing these population declines."); NYS Governor's Office, Press Release, *With American Shad Stocks at Historically Low Levels, Governor Paterson Announces New Initiatives to Rebuild and Protect Hudson River Fisheries* (May 28, 2008), *available at*, http://www.state.ny.us/governor/press/press_0528082.html (last visited March 24, 2010) (In the context of announcing that Hudson River fisheries are in trouble, recognizing that "[t]he number of fish entering water intake pipes each year at the two Indian Point nuclear power plants alone is significant – over 1.2 billion fish eggs and larvae, including bay anchovy, striped bass, and Atlantic tomcod – with the vast majority dying during the process. Another 1.18 million fish per year become trapped against intake screens and likely die."). Entergy's insistence on relying upon an obsolete cooling technology and refusal to implement a far-superior closed-cycle system, would lead to two additional decades of enormous entrainment, impingement, and heat impacts on an already precarious ecosystem. This will lead to ongoing habitat degradation, and only further exacerbate the current decline and destabilization of Hudson River fish populations.

[17] *See* Riverkeeper Comments on Indian Point Dec. 2008 DSEIS, *supra* Note 6, at 9.

[18] *See generally supra* Note 16.

on Environmental Quality ("CEQ") regulations implementing the National Environmental Policy Act ("NEPA"), which require that analyses in environmental impact statements have scientific integrity.[19]

For the foregoing reasons, NRC Staff's revised assessment of impingement and entrainment impacts caused by Indian Point remains inadequate.

NRC Staff's Revised Analysis of Thermal Discharge Impacts at Indian Point

NRC Staff's Draft FSEIS Supplement assesses "additional information from Entergy regarding the thermal plume" at Indian Point, and based upon that assessment, NRC Staff makes an allegedly "more informed conclusion regarding thermal impacts" of the plant.[20] In particular, NRC Staff reviewed a triaxial plume study that Entergy submitted to the New York State Department of Environmental Conservation ("DEC") as part of its State Pollutant Discharge Elimination System ("SPDES") permit renewal proceeding and Clean Water Act § 401 water quality certification denial appeal proceeding, correspondence between DEC and Entergy relating to this thermal study, and a DEC proposed determination that a 75-acre thermal mixing zone will provide reasonable assurance that the operation of Indian Point will comply with applicable regulations.[21] Whereas in NRC Staff's initial (December 2010) FSEIS, NRC Staff concluded that thermal impacts at Indian Point ranged from SMALL to LARGE, based on NRC Staff's review of the aforementioned new information, the Draft FSEIS Supplement indicates that now "NRC staff concludes that the impacts from heat shock to aquatic resources of the lower Hudson River would be SMALL."[22]

However, NRC Staff's changed conclusion is unjustified because Entergy's thermal study and DEC's *proposed* determination regarding the efficacy of a mixing zone, are highly disputed, namely by Riverkeeper, and currently the subject of ongoing adjudication. Indeed, Pisces' review of the thermal study after it was completed, resulted in detailed comments that outlined numerous concerns related to thermal impacts on aquatic ecology at Indian Point, and problems with Entergy's thermal study. These comments are included as Appendix 1 to Attachment A hereto.[23] Pisces' comments reveal that despite Entergy's thermal study and DEC's proposed mixing zone, thermal discharges from Indian Point will continue to pose a threat to the aquatic ecology of the river.[24] Moreover, Riverkeeper has vehemently opposed DEC's *proposal* to allow Entergy to operate with a mixing zone, raising numerous well-founded concerns about the legality and environmental efficacy of doing so. A copy of Riverkeeper's comments on DEC's

[19] *See* 40 C.F.R. § 1502.24; *see also id.* § 1502.22.

[20] Draft FSEIS Supplement at 17.

[21] *Id.*

[22] *Id.* at 20.

[23] Attachment A – Pisces Memo, at Appendix 1 – Pisces Conservation Ltd, "Comments on the proposed Indian Point thermal mixing zone" (July 15, 2011).

[24] *See id.* at pages 16 of 22 to 20 of 22.

proposed mixing zone at Indian Point is included with these comments as Attachment B.[25] This issue is currently the subject of *ongoing* adjudication in State proceedings before DEC. Thus, NRC Staff cannot simply indicate that "NYSDEC concluded that the results of the thermal plume studies provide reasonable assurance that the IP2 and IP3 discharge is in compliance with NYSDEC's water quality standards and criteria for thermal discharges," and thereby conclude that impacts of heat shock at Indian Point are SMALL.[26] Riverkeeper has raised valid concerns (that have yet to be fully resolved), which call into question Entergy's thermal study and DEC's proposed conclusions with respect to thermal impacts, and, in turn, NRC Staff's revised conclusions in the Draft FSEIS supplement.

For the foregoing reasons, NRC Staff's revised assessment of thermal impacts caused by Indian Point remains inadequate.

NRC Staff's "Update" on Endangered Species Act § 7 Consultations

NRC Staff's Draft FSEIS Supplement lastly discusses endangered species impacts at Indian Point.[27] First, NRC Staff discusses endangered shortnose sturgeon. In particular, NRC Staff revises its assessment of Indian Point's thermal impact on endangered shortnose sturgeon.[28] NRC Staff's revised conclusion "that the heated discharge resulting from the proposed IP2 and IP3 license renewal would have SMALL impacts on the shortnose sturgeon," is largely based on NRC Staff's consideration of Entergy's thermal study discussed above.[29] Riverkeeper respectfully submits that, due to the reasons discussed above regarding the potential ongoing thermal impacts from Indian Point, NRC Staff's conclusions are not entirely well-founded.[30] Moreover, Pisces specifically notes in relation to NRC Staff's Draft FSEIS Supplement that the NRC Staff's finding that there is a "SMALL" level of impact on endangered shortnose sturgeon at Indian Point requires verification.[31]

---

[25] Letter from Mark Lucas (Riverkeeper) to Christopher M. Hogan (DEC), Re: *Entergy Nuclear Indian Point 2, LLC & Entergy Nuclear Indian Point 3, LLC Proposed Modification of Special Condition 7.b of SPDES Permit, DEC No.* 3-5522- 00011/00004, SPDES No. NY-000472 (July 15, 2011) (Attachment B).

[26] Draft FSEIS Supplement at 20.

[27] *Id.* at 23-26.

[28] *Id.* at 23-24.

[29] *Id.*

[30] *See* Attachment A – Pisces Memo, at Appendix 1 – Pisces Conservation Ltd, "Comments on the proposed Indian Point thermal mixing zone" (July 15, 2011); Attachment B -- Letter from Mark Lucas (Riverkeeper) to Christopher M. Hogan (DEC), Re: *Entergy Nuclear Indian Point 2, LLC & Entergy Nuclear Indian Point 3, LLC Proposed Modification of Special Condition 7.b of SPDES Permit, DEC No.* 3-5522- 00011/00004, SPDES No. NY-000472 (July 15, 2011).

[31] *See id.* Moreover, it remains unclear whether, generally, the impact of Indian Point on shortnose sturgeon is "small." *See* Riverkeeper Comments on Indian Point Dec. 2008 DSEIS, at Appendix A (Pisces indicating that there is no reason to believe that an increasing population of shortnose sturgeon would lead to decrease in impingement and that with relatively rare fish, even a small number of impingement can have a big effect, and calling into question the ability of the NRC Staff to draw accurate conclusions based on obsolete data).

NRC Staff's Draft FSEIS Supplement further memorializes the outcome of NRC Staff's Endangered Species Act ("ESA") section 7 consultations with NMFS concerning the impact of Indian Point on endangered shortnose sturgeon. Based on NRC Staff's mere summary of the sequence and outcome of the consultation process, NRC Staff has failed to comply with relevant regulations and guidance, which require *meaningful consideration* of the opinions and conclusions drawn by NMFS.[32] Indeed, NRC Staff does not indicate how NMFS' final biological opinion regarding endangered shortnose sturgeon affects it's NEPA-based analysis and conclusions regarding impacts to endangered resources. Instead, NRC Staff's discussion of the section 7 consultation process in the Draft FSEIS Supplement appears to be a purely opportunistic discussion, provided only because NRC Staff was issuing a draft supplement to address other issues anyway. This is further exemplified by NRC's treatment (i.e., acceptance) of the incomplete section 7 consultation process with respect to the newly endangered Atlantic sturgeon, as discussed forthwith. As discussed below, more is required by controlling law and guidance.

In relation to Atlantic sturgeon, in light of the designation of this species as endangered on February 6, 2012, i.e., after the issuance of NRC Staff's December 2010 FSEIS, NRC Staff reinitiated section 7 consultation with NMFS.[33] However, NRC Staff simply indicates in the Draft FSEIS Supplement that it expects to carry on consultation procedures and "consider the results of that consultation, as appropriate."[34] This fails to assure compliance with NEPA, which requires full consideration of the consultation process and the opinions, conclusions, and recommendations of NMFS, *as part of* the NEPA assessment process. NRC Staff must include or consider NMFS' assessment, and issue a supplemental EIS to fully consider the outcome of the new section 7 consultation process. This must be accomplished prior to the finalization of the NEPA process concerning the proposed license renewal of Indian Point, and prior to any ultimate decision by the NRC regarding whether to relicense Indian Point.

In particular, the ESA provides that

> [e]ach Federal agency shall, in consultation with . . . the Secretary [of the Interior or Commerce as appropriate], insure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered species or

[32] *See* Endangered Species Consultation Handbook, *Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act,* U.S. Fish &Wildlife Service, National Marine Fisheries Service (March 1998), at 4-11, *available at* http://www.nmfs.noaa.gov/pr/pdfs/laws/esa_section7_handbook.pdf (hereinafter "NMFS Consultation Handbook"); 50 C.F.R. § 402.06(b); Interagency Cooperation – Endangered Species Act of 1973, as Amended, Final Rule, 51 Fed. Reg. 19,926 (1986); 50 C.F.R. § 402.15; ESA § 7(d), 16 U.S.C. § 1536(d).

[33] *See* Draft FSEIS Supplement at 26.

[34] *See id.* As of the date of these comments, the consultation process between NRC Staff and NMFS remains ongoing. *See* Correspondence from Amy Hull (NRC) to Mr. Daniel S. Morris (NMFS), Re: Response to Request for Additional Review Time for Endangered Species Act Section 7 Consultation at Indian Point Nuclear Generating Unit Nos. 2 and 3 (Aug. 17, 2012), ADAMS Accession No. ML12221A033 (approving a 60-day extension of the consultation process whereby NMFS agreed to provide NRC a draft biological opinion on October 22, 2012 for a two-week review and indicating that consultation will be completed by November 28, 2012).

threatened species or result in the destruction or adverse modification of habitat of such species which is determined . . . to be critical."[35]

During formal consultation, NMFS must review all relevant information, evaluate the current status of the relevant listed species, evaluate the effects of the proposed action and cumulative effects on the listed species, formulate an opinion regarding whether the proposed action is likely to jeopardize the continued existence of the listed species, formulate discretionary conservation recommendations that would reduce or eliminate the impacts of the proposed action on listed species, formulate a statement concerning any incidental take of the listed species,[36] and formulate an opinion regarding any reasonable and prudent alternatives to the proposed project and reasonable and prudent measures that could be taken.[37] Formal consultation concludes when NMFS issues a "biological opinion" ("BO").[38] Once NMFS issues its BO, "the Federal agency shall determine whether and in what manner to proceed with the action in light of its section 7 obligations and the Service's biological opinion."[39]

In addition, NRC's NEPA-implementing regulations designate the impacts of license renewal on threatened or endangered species as a "Category 2" issue, i.e. one that requires site specific review during individual relicensing proceedings.[40] NRC's regulations acknowledge that "consultation with appropriate agencies would be needed at the time of license renewal *to determine* whether threatened or endangered species are present and *whether they would be adversely affected*."[41]

Federal regulations implementing the ESA contemplate coordination of the consultation process with environmental reviews pursuant to NEPA.[42] NMFS guidance on the consultation process further explains how

[35] ESA § 7, 16 U.S.C. § 1536(a)(2).

[36] A statement from NMFS concerning any incidental take must specify the amount or extent of the impact, any "reasonable and prudent measures that the Director considers necessary or appropriate to minimize such impacts," and any "terms and conditions (including but not limited to, reporting requirements) that must be complied with by the Federal agency or any applicant to implement [such] measures." 50 C.F.R. § 402.14(i).

[37] *See* 50 C.F.R. § 402.14(g)

[38] *See id.* § 402.14(l).

[39] *Id.* § 402.15.

[40] *See* 10 C.F.R. Part 51, Table B-1 of Appendix B to Subpart A; GEIS § 3.9 ("Because compliance with the Endangered Species Act cannot be assessed without site-specific consideration of potential effects on threatened and endangered species, it is not possible to determine generically the significance of potential impacts to threatened and endangered species. This is a Category 2 issue.").

[41] 10 C.F.R. Part 51, Table B-1 of Appendix B to Subpart A (emphasis added).

[42] *See* 50 C.F.R. § 402.06(a) ("Consultation, conference, and biological assessment procedures under section 7 may be consolidated with interagency cooperation procedures required by other statutes, such as the National Environmental Policy Act. . . . The Service will attempt to provide a coordinated review and analysis of all environmental requirements.").

> [f]ormal consultation and the Services' preparation of a biological opinion often involve coordination with the preparation of documents mandated by other environmental statutes and regulations, including . . . NEPA. . . . The Services should assist the action agency or applicant in *integrating the formal consultation process into their overall environmental compliance.*[43]

Pertinently, ESA regulations and the NMFS Consultation Handbook indicate that "[a]t the time the Final EIS is issued, *section 7 consultation should be completed*" and that "[t]he Record of Decision should *address the results of section 7 consultation.*"[44] Indeed, only *after* the issuance of a BO can the Federal agency "determine whether and in what manner to proceed with the action in light of its section 7 obligations and the Service's biological opinion."[45] This settled and proper approach is demonstrated by numerous instances where ESA § 7 consultation processes were concluded well prior to the completion of a concurrent NEPA review process, and where a BO prepared by NMFS (or FWS) was incorporated into the final EIS and formed part of the basis for the Federal agency's final decision-making.[46]

---

[43] NMFS Consultation Handbook, *supra* Note at 32, at p.4-11 (emphasis added); *see id.* ("A major concern of action agencies is often the timing of the consultation process in relation to their other environmental reviews. For example, since the time required to conduct formal section 7 consultation may be longer than the time required to complete preparation of NEPA compliance documents, the action agency should be encouraged to initiate informal consultation prior to NEPA public scoping. Biological assessments may be completed prior to the release of the Draft Environmental Impact Statement (DEIS) and formal consultation, if required, should be initiated prior to or at the time of release of the DEIS. Early inclusion of section 7 in the NEPA process would allow action agencies to share project information earlier and would improve interagency coordination and efficiency.").

[44] *Id.* (emphasis added); *see* 50 C.F.R. § 402.06(b) ("Where the consultation . . . has been consolidated with the interagency cooperation procedures required by other statutes such as NEPA . . ., the results should be included in the documents required by those statutes."); Interagency Cooperation – Endangered Species Act of 1973, as Amended, Final Rule, 51 Fed. Reg. 19926 (1986) (NMFS and the U.S. Fish and Wildlife Service ("FWS") jointly enacting regulations implementing the ESA, explaining that "the biological opinion *should be stated in the final environmental impact statement*") (emphasis added); *id.* (explaining that "[a] statement of the opinion may be a summary of its findings and conclusions" although "[t]he Service does feel that the entire opinion should be attached as an exhibit to the NEPA document if completion time permits.").

[45] 50 C.F.R. § 402.15; *see also* ESA § 7(d), 16 U.S.C. § 1536(d) (prohibiting agency action that forecloses formulation of reasonable measures/alternatives while consultation is ongoing).

[46] *See, e.g., National Parks & Conservation Ass'n v. U.S. Dep't of Transportation*, 222 F.3d 677, 679, 682 (9th Cir. 2000) (BA and BO prepared pursuant to ESA both incorporated into Federal agency's Final EIS, forming part of the basis for agency's informed decision, which satisfied NEPA); *Miccosukee Tribe of Indians of Fla. V. U.S. Army Corp. of Eng'rs*, 509 F. Supp. 2d 1288, 1294 (S.D. Fla. 2007) (Army Corp appending BO to final supplemental EIS and pointing to "years of consultation and cooperation with the FWS which preceded the FSEIS" to justify its environmental analysis; Court finding that "the analysis in the FSEIS, *including the attached BiOpp*, [biological opinion] is sufficient") (emphasis added); *Nw. Envtl. Advocates v. NMFS*, 2005 U.S. Dist. LEXIS 41828, *6 (W.D. Wash. 2005) (Federal agency "solicited comments on its draft FSEIS, *including the NMFS Biological Opinion.* After considering and responding to the public comments, the Corps issued its FSEIS"); *Seattle Audubon Society v. Lyons*, 871 F. Supp. 1291, 1305, 1314, 1320 (W. D. Wash. 1994) (FWS issued a biological opinion that was appended to the final EIS concerning a federal forest management plan, which formed part of basis for the Federal agency's final determinations).

Since Atlantic sturgeon was listed after NRC Staff's issuance of the Indian Point license renewal FSEIS, there was no consultation process to be incorporated into the December 2010 FSEIS. However, this does not relieve NRC Staff of the obligation to ensure proper consideration of the now ongoing section 7 consultation procedures. NRC Staff's vague reference to potentially considering the outcome of the section 7 consultation process related to Atlantic sturgeon does not ensure that the impacts to this critical species will be adequately considered by NRC Staff in the Indian Point relicensing NEPA process. Indeed, there is no indication that NRC Staff's NEPA review will fully address the findings, conclusions, or recommendations of NMFS relating to endangered Atlantic sturgeon present in the Hudson River. Based on the pithy "update" provided in the NRC Staff's Draft FSEIS Supplement, it appears that NRC Staff may continue to rely on its own analysis, and not on the input to be provided by NMFS. While the Draft FSEIS Supplement recognizes that the consultation process remains open, NRC Staff did not address in any way how the very relevant, as yet unwritten BO by NMFS would factor into the NRC Staff's FSEIS or NRC Staff's final decision-making regarding the license renewal of Indian Point.

This renders NRC Staff's Draft FSEIS Supplement and NEPA process fundamentally flawed. NRC Staff's apparent position that completing the NEPA review related to the proposed relicensing of Indian Point prior to the completion of the ESA § 7 consultation process with NMFS concerning Atlantic sturgeon, runs contrary to the ESA, applicable regulations and guidance, and settled practice, as discussed above. NRC simply cannot arrive at final NEPA conclusions regarding impacts to endangered Atlantic sturgeon and, ultimately whether to recommend license renewal of Indian Point, without satisfying its ESA § 7 obligations and fully considering NMFS' prospective biological opinion.[47] Indeed, such a regulatory scheme is the only way to ensure adequate and appropriate consideration of impacts to endangered or threatened species, and thereby comply with basic tenets of NEPA. The fundamental purpose of NEPA is to "ensure[] that the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts" and to "guarantee[] that the relevant information will be made available to the larger audience that may also play a role in both the decisionmaking process and the implementation of that decision."[48] Thus, an EIS prepared pursuant to NEPA must be searching and rigorous, providing a "hard look" at the environmental consequences of the agency's proposed action.[49] It is impossible to conclude that NRC Staff's final determinations in the ultimate final FSEIS supplement can be

[47] *See* 50 C.F.R. § 402.15 (only *after* the issuance of a BO can the Federal agency "determine whether and in what manner to proceed with the action in light of its section 7 obligations and the Service's biological opinion."); *see also* ESA § 7(d), 16 U.S.C. § 1536(d) (prohibiting agency action that forecloses formulation of reasonable measures/alternatives while consultation is ongoing).

[48] *Entergy Nuclear Generation Co. and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station), LBP-06-23, 64 NRC 257, 277 (2006), quoting *Robertson v. Methow Valley Citizens Council,* 490 U.S. 332, 349 (1989); *see also Vermont Yankee Nuclear Power Corp. V. Natural Resources Defense Council,* 435 U.S. 519, 558 (1978) (explaining how NEPA seeks to ensure "a fully informed and well-considered decision"); *Nw. Envtl. Advocates v. NMFS,* 2005 U.S. Dist. LEXIS 41828, *6 (W.D. Wash. 2005) ("The processes established under NEPA focus the attention of both the government and the public on a proposed agency action, so that the environmental consequences can be studied prior to implementation of the proposed action, and so potential negative impacts can be avoided") (citing 40 C.F.R. § 1500.1(b); 40 C.F.R. § 1500.2(e); *Marsh v. Oregon Natural Resources Council,* 490 U.S. 360, 371 (1989); *Churchill County v. Norton,* 276 F.3d 1060, 1072-73 (9th Cir. 2001)).

[49] *Marsh,* 490 U.S. at 374.

considered "fully-informed" and based on the requisite "hard look," if they are not informed by *any* feedback from the ESA § 7 consultation process related to Atlantic sturgeon (or if an additional supplement to the FSEIS is not prepared upon completion of the section 7 consultation process). Indeed, finalizing the NEPA process without the benefit of NMFS' assessment effectively ensures that NRC Staff's determinations regarding impacts to endangered species and the license renewal of Indian Point will not take into account any conclusions, findings, or recommendations of the consulting agency. This completely flouts the purpose of ESA § 7, which requires consultation with NMFS so as to inform the Federal agency's decision on the action to make certain that such action will not jeopardize any endangered species.[50]

For example, NMFS is charged with making an independent determination regarding whether the proposed action is likely to jeopardize any endangered species, making discretionary conservation recommendations to reduce or eliminate any impacts, determining whether a take permit is necessary, and formulating an opinion regarding any reasonable and prudent alternatives to the proposed project.[51] The opinions and recommendations from NMFS are highly critical given NRC Staff's continued reliance on outdated and/or incomplete information regarding impacts to Atlantic sturgeon.[52] NMFS' assessment will contain opinions that will necessarily inform the relevant concerns, including opinions and conclusions that may well differ from those of NRC Staff, and that logically should be considered before NRC Staff arrives at any final conclusions about impacts to endangered species and, in turn, whether license renewal of Indian Point is appropriate. Without the benefit of NMFS' BO (which will contain NMFS' position on the impacts of the activity, potential alternatives, mitigation measures, the necessity of obtaining a take permit, etc), NRC Staff does not have all of the information necessary to make the relevant findings regarding the license renewal of Indian Point. Failure to fully consider the section 7 consultation process related to Atlantic sturgeon will result in determinations by NRC Staff that do not adequately take into account adverse impacts on endangered species, which NMFS may find to be significant and "likely to jeopardize the continued existence" of such species.[53]

In sum, NRC Staff cannot draw final conclusions regarding the impact of Indian Point on Atlantic sturgeon in the Hudson River, or finalize the NEPA review process concerning the proposed license renewal of Indian Point, without a full and adequate consideration of the section 7 consultation process and input from NMFS. Notably, Pisces agrees that "[w]ithout more information an assessment for the Atlantic sturgeon is not possible."[54] A site specific assessment of environmental impacts of license renewal on Atlantic sturgeon is necessary for

[50] *See* 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(g).

[51] *See* 50 C.F.R. § 402.14(g).

[52] *See, e.g.*, U.S. NRC, Biological Assessment for Reinitiation of Section 7 Consultation for the Indian Point Nuclear Generating Plant, Unit Nos. 2 and 3 Due to Listing of Atlantic Sturgeon, May 2012, ADAMS Accession No., ML12138A388, at 4, 10, Appendix A; *see also* Revised Biological Assessment of the Potential Effects on Federally Listed Endangered or Threatened Species from the Proposed Renewal of Indian Point Nuclear Generating Plant, Unit Nos. 2 and 3 (December 2010), ADAMS Accession No. ML102990046 (basing conclusions on "two-decade old impingement data and incomplete impingement mortality data.").

[53] *See* 50 C.F.R. § 402.14(g)(4).

[54] Attachment A – Pisces Memo at p.3 of 22.

NRC Staff to make informed conclusions in the FSEIS, and, in turn, informed recommendations regarding the appropriateness of relicensing Indian Point. Without meaningful consideration of NMFS' analysis pursuant to consultation procedures set forth by ESA § 7, the current findings in the FSEIS and Draft FSEIS Supplement in relation to impacts to endangered and threatened species lack proper foundation and are flawed and patently deficient.

For the foregoing reasons, NRC Staff's revised assessment of endangered species impacts caused by Indian Point remains inadequate.

NRC Cannot Issue Renewed Operating Licenses to Indian Point Unless and Until Entergy Obtains All Required and Necessary State Approvals and Certifications

Lastly, to the extent clarity is required notwithstanding the fact that the record is abundantly clear in the Indian Point license renewal proceeding, Riverkeeper reiterates the position that Entergy must obtain a new water quality certification pursuant to CWA § 401 prior to any license renewal for the plant. NRC Staff's December 2010 FSEIS acknowledged the ongoing nature of Entergy's appeal proceeding relating to NYSDEC's denial of Entergy's request for a CWA § 401 water quality certification.[55] In light of a recent United States Court of Appeals decision that was issued after the publication of NRC Staff's FSEIS, it may be useful to include in NRC Staff's supplemental NEPA document an explanation regarding the unequivocal obligation of the NRC to comply with CWA § 401, and the distinguishing nature of the recent court ruling; Riverkeeper's position is fully explained in a letter that was provided to the NRC on July 26, 2012, which is included with these comments as Attachment C.[56]

Notably, as NRC Staff has previously acknowledged in its initial FSEIS, Indian Point must receive a federal consistency determination from the State pursuant to the Coastal Zone Management Act[57] before NRC may issue operating licenses authorizing the operation of Indian Point Units 2 & 3 beyond their initial 40-year terms.[58] NRC may not issue a license renewal prior to the issuance of the federal consistency concurrence by the Department of State pursuant to 16 U.S.C. § 1456(3)(A), which requires that "[n]o license or permit shall be granted by the

[55] Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 1, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Docket Nos. 50-247 and 50-286 (December 2010), *available at*, http://pbadupws.nrc.gov/docs/ML1033/ML103350405.pdf, at xv ("Two state level issues (consistency with State water quality standards, and consistency with State coastal zone management plans) need to be resolved. On April2, 2010, the New York State Department of Environmental Conservation (NYSDEC) issued a Notice of Denial regarding the Clean Water Act Section 401 Water Quality Certification. Entergy has since requested a hearing on the issue, and the matter will be decided through NYSDEC's hearing process."); *see id.* at xvii-xviii, 1-8, 2-27, 4-8 to 4-9, 4-30, 8-3, 9-5, A-151.

[56] Letter from Deborah Brancato (Riverkeeper) to NRC Commissioners, Re: Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-247-LR 50-286- LR (July 26, 2012) (Attachment C).

[57] 16 U.S.C. §§ 1451–1464.

[58] *See* Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 - Final Report, Main Report and Comment Responses (NUREG-1437, Supplement 38, Volume 1), *available at*, http://pbadupws.nrc.gov/docs/ML1033/ML103350405.pdf, (last visited Aug. 20, 2012), at pp. 1-8, 2-141, 2-142 ("Based on IP2 and IP3's location within the State's Coastal Zone, license renewal of IP2 and IP3 will require a State coastal consistency certification").

Federal agency until the state or its designated agency [DOS] has concurred with the applicant's certification."[59]

Based on the forgoing, NRC Staff's revised Draft FSEIS Supplement contains flawed analyses and conclusions, and, as a result, NRC has yet to fully and adequately comply with NEPA in relation to the proposed license renewal of Indian Point.

Thank you for your consideration.

Respectfully submitted,

Deborah Brancato

Deborah Brancato
Staff Attorney

Phillip Musegaas, Esq.
Hudson River Program Director

[59] Federal regulations at 15 C.F.R. Part 930 sets forth these procedures; notably, a federal determination is no substitute for the State determination.

Docket ID NRC-2008-0672

Attachment A

to

Riverkeeper, Inc.'s Comments on the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50–247 and 50–286 (June 2012)

To: **Deborah Brancato**

From: **Richard Seaby and Peter Henderson**

Date: **20/8/12**

Some notes on the Generic Environmental Impact Statement for License Renewal of Nuclear Plants - Supplement 38

1 Introduction

Pisces was asked to comment on the Generic Environmental Impact Statement for License Renewal of Nuclear Plants - Supplement 38 Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 Draft Report for Comment, June 2012.

This document covered several areas:

1. It corrected some errors in the calculations, reassessing species where this made a difference to the analysis
2. Looked at the thermal impact in light of the Entergy triaxial study
3. Reviewed the effects on sturgeon

In this memo we look at these in turn and relate them to our original document "Comments relating to the Indian Point NRC draft EIS on the Cooling System. P. A. Henderson & R. M. H. Seaby – March 2009"

2 Calculation errors

These errors were caused by confusion due to the presentation of data supplied by Entergy, which did not give the correct units.

In its technical review, AKRF (2011b) stated that the units of the entrainment catch densities provided by Entergy are expressed as the number caught per 1,000 cubic meters (m3). Because Entergy did not originally provide the units used in the FSEIS to assess impacts, the NRC staff believed the units to be the number caught/m3 based on historical documents provided by Entergy, comments by Entergy and its consultants on the draft SEIS, and phone conversations among Entergy, Entergy's consultants, and NRC staff. Thus, the entrainment losses the FSEIS reported for each of the representative important species (RIS) used in the NRC staff's analysis [is] too large by a factor of 1,000.

The NRC shows where these corrections are needed in the document. In most cases the error in units cancelled themselves out i.e. 1,000/2,000 is the same as 1,000,000/2,000,000

2.1 *Spottail shiner*

This species was the only species greatly affected by the changes. This is because the beach seine survey (BSS) was important in the standing crop calculations, and the unit error did not cancel itself out in this case.

According to the NRC, the impact on spottail shiner became SMALL from LARGE in the previous assessment.

2.2 *All the species*

Even with the impact on spottail shiner now at small, eight species are still shown as having a high strength of connection to the effect of the power plant.

Table 4-4. Impingement and Entrainment Impact Summary for Hudson River YOY RIS

Species	Population Trend Line of Evidence	Strength of Connection Line of Evidence	Impacts of IP2 and IP3 Cooling Systems on YOY RIS
Alewife	Variable	High	Moderate
American Shad	Detected Decline	Low	Small
Atlantic Menhaden	Unresolved[(a)]	Low[(b)]	Small
Atlantic Sturgeon	Unresolved[(a)]	Low[(b)]	Small
Atlantic Tomcod	Detected Decline	Low	Small
Bay Anchovy	Undetected Decline	High	Small
Blueback Herring	Detected Decline	High	Large
Bluefish	Detected Decline	Low	Small
Gizzard Shad	Unresolved[(a)]	Low[(b)]	Small
Hogchoker	Detected Decline	High	Large
Rainbow Smelt	Variable	High	Moderate-Large[(c)]
Shortnose Sturgeon	Unresolved[(a)]	Low[(b)]	Small
Spottail Shiner	Detected Decline	~~High~~ **Low**	~~Large~~ **Small**
Striped Bass	Undetected Decline	High	Small
Weakfish	Variable	High	Moderate
White Catfish	Variable	Low	Small
White Perch	Detected Decline	High	Large
Blue Crab	Unresolved[(a)]	Low[(b)]	Small

(a) Population trend could not be established because of a lack of river survey data.
(b) Monte Carlo simulation could not be conducted because of the low rate of entrainment and impingement; a Low Strength of connection was concluded.
(c) Section 4.1.3.3 provides supplemental information.

Some of these high connections are calculated to have small impacts, although alewife, blueback herring, rainbow smelt, weakfish and white perch are all still analysed as having high connection and moderate of large impacts.

Pisces Conservation Ltd
IRC House, The Square
Pennington, Lymington
Hampshire, SO41 8GN, UK
pisces@pisces-conservation.com
www.irchouse.demon.co.uk
www.pisces-conservation.com
Phone: 44 (0) 1590 674000
Fax 44 (0) 1590 675599

2.3 *The effect on the original Pisces memo*

None of the changes alter the criticism of the method, or the conclusions drawn in relation to the scoring system used to assess impingement and entrainment.

3 Thermal studies

Entergy has undertaken a triaxial study of Indian Point's thermal plume in relation to the cooling tower/wedgewire screen case. It was reviewed in depth for this case and the memo is presented in Appendix 1.

4 Sturgeon

The NRC changes its opinion on the effect on sturgeon in light of comments and consultations on these species from undetermined to small. It based this on information on shortnose sturgeon. The consultation for Atlantic sturgeon has not yet been completed. For the shortnose sturgeon this does not seem unreasonable, but should be checked with someone with local knowledge of the populations. Without more information an assessment for the Atlantic sturgeon is not possible.

5 Summary

The NRC corrected some errors in calculations, and assessed new information with regard to thermal pollution and sturgeon.

The impingement and entrainment comments and conclusions made previously (2009) were not affected by the changes.

The triaxial thermal study is discussed in the attached document.

The impact on Sturgeon has been found to be small based on shortnose sturgeon only.

Appendix 1

To: Riverkeeper Inc.

From: Richard Seaby and Peter Henderson

CC:

Date: 7/15/2011

Re: Thermal issues at Indian Point

Comments on the proposed Indian Point thermal mixing zone

These comments are made in reference to the report entrainment, impingement and thermal impacts at Indian Point Nuclear power station, Pisces Conservation ltd, 2007 are incorporated here by reference.

1 The Hudson River resource at issue and its vulnerability

The Hudson River estuary is one of the major estuarine systems on the east coast of the USA. It acts as both an important nursery and breeding ground for marine animals and fish in particular. Key commercial and recreational species like striped bass, bluefish, and blue crab depend upon the estuary for nursery habitat. It supports huge populations of small forage fish such as bay anchovy which are prey for the larger predatory species. Further, it is the migratory route by which anadromous[1] and catadromous[2] fish move between their spawning and feeding grounds. Haverstraw Bay, immediately to the south of Indian Point, is known as an important feeding habitat for both the Atlantic and shortnose sturgeon.The Hudson River, up to the federal dam in Troy, has been designated as Essential Fish Habitat. See National Estuarine Inventory: Data Analysis - Vol. 1: Physical and Hydrological Characteristics, Strategic Assessment Branch, Office of Oceanography and Marine Assessment, NMFS.

The Hudson River estuary is one of the most species-rich temperate estuaries in the world; about 140 fish species have been recorded from the Hudson estuary. This probably relates to its unique geographical position, which enables it to support cold water species such as the Atlantic tomcod during the winter, and many warm water species during the summer. The estuary's productivity is ecologically and economically valuable to the fisheries and aquatic ecosystem to a wide expanse of the Atlantic coast of the USA.

[1] Anadromous fish live in the sea and migrate to fresh water to breed. An example is the American shad.
[2] Catadromous fish spend most of their lives in fresh water, then migrate to the sea to breed. The most well-known example is the American eel.

The Hudson River estuary holds extensive areas of significant fish habitat. Just to the north of Indian Point, Hudson River mile 44-56 is designated by Department of State as a Significant Coastal Fish and Wildlife Habitat and offers significant spawning habitat for striped bass and white perch.

It is now proposed to designate the region between river miles 40 and 60 as Significant Coastal Fish and Wildlife Habitat. This region encompasses the Hudson Estuary where Indian Point extracts and discharges large volumes of cooling water (about 2.5 billion per day). It also offers nursery habitat for species that spawn elsewhere, including sturgeon.

The proposed regulations state

Any activities that would degrade water quality, increase turbidity, increase sedimentation, or alter flows, temperature, or water depths in the Hudson River Miles 40-60 would result in significant impairment of the habitat. Of primary concern in this deep estuarine area would be diversion of freshwater flows out of the Hudson, contamination by toxic chemicals, major structural alterations to the underwater habitat (e.g., dredging, filling, or construction of jetties), and thermal discharges. (http://www.nyswaterfronts.com/downloads/pdfs/sig_hab/HudsonRiverJune/Hudson%20 River%20Mile%2040-60.pdf)

Three miles to the south of Indian Point lies Haverstraw Bay which is also a significant coastal fish and wildlife habitat. Haverstraw Bay possesses a combination of physical and biological characteristics that make it one of the most important fish and wildlife habitats in the Hudson River estuary. The Coastal Fish and Wildlife Habitat Rating Form states;

"Haverstraw Bay is also a major nursery and feeding area for certain marine species, most notably bay anchovy, Atlantic menhaden, and blue claw crab. Depending on location of the salt front, a majority of the spawning and wintering populations of Atlantic sturgeon in the Hudson may reside in Haverstraw Bay. Shortnose sturgeon (E) usually winter in this area as well. Significant numbers of waterfowl may occur in Haverstraw Bay during spring (March-April) and fall (September-November) migrations, but the extent of this use is not well documented.

Haverstraw Bay is a critical habitat for most estuarine-dependent fisheries originating from the Hudson River. This area contributes directly to the production of in-river and ocean populations of food, game, and forage fish species. Consequently, commercial and recreational fisheries throughout the North Atlantic depend on, or benefit from, these biological inputs from the Hudson River estuary".

The Hudson River is highly important to the region. Perhaps the best example is the spawning of striped bass which is centred on River Miles 44-56, just north of Indian Point. As noted in the Coastal Fish and Wildlife Habitat Rating Form for this region

Pisces Conservation Ltd
IRC House, The Square
Pennington, Lymington
Hampshire, SO41 8GN, UK
pisces@pisces-conservation.com
www.irchouse.demon.co.uk
www.pisces-conservation.com
Phone: 44 (0) 1590 674000
Fax 44 (0) 1590 675599

"Striped bass stock discrimination studies conducted in coastal New York and southern New England indicate that approximately 50 percent of striped bass harvested in these fisheries were of Hudson River origin, the remainder primarily originating from the Chesapeake Bay system. With the documented poor Chesapeake production from 1983-1985, it is anticipated that the relative contribution of the Hudson stock to the coastal migratory striped bass population will continue to rise above 50 percent."

For striped bass, the area close to Indian Point is now the most important spawning ground along the entire Atlantic east coast of the USA.

Daniels 2005 showed species such as rainbow smelt and tomcod are in decline over the whole river[3]. The Pisces (2008) report The Status of Fish Populations and Ecology of the Hudson supports the view that many species are in decline. It concludes that

"the fish community has been changing rapidly since 1985 and is now showing clear signs of increased instability with greater year-to-year variation in abundance. ....The population abundance and dynamics of 13 key species subject to intensive study. Three species, striped bass, bluefish and spottail shiner, show a trend of increasing abundance since the 1980s. The other 10 species, including shad, tomcod and white perch, have declined in abundance, some greatly. ... Many other important species of fish not included within the key 13 species are also showing long-term declines in abundance. An important example of a once abundant fish now in decline is the American eel. All the evidence points to the Hudson estuary ecosystem presently being in a state of change, with declining stability. Neither the ecosystem as a whole, nor many of the individual constituent species' populations, is in a healthy state."

The Department's regulatory role includes limiting thermal discharges from each facility to ensure the survival of aquatic resources (NYSDEC 2003 FEIS). It was noted in the FEIS that Indian Point did not meet its water quality criteria.

This plant has been operating since the 1970, and producing a large thermal discharge into the valuable habitats of the Hudson. The situation with regards to thermal plume has not changed.

2 The adverse impacts from thermal discharges and specifically that of Indian Point

The discharge of heated water from cooling systems has been shown to harm fish and wildlife and has long been recognized to have effects upon the structure and function of ecosystems (EPA Environmental and Economic Benefits Analysis for Proposed Section

[3] Daniels, R.A., K. E. Limburg, R. E. Schmidt, D. L. Strayer And R. C. Chambers (2005) Changes in Fish Assemblages in the Tidal Hudson River, New York. American Fisheries Society Symposium 45:471–50

Pisces Conservation Ltd
IRC House, The Square
Pennington, Lymington
Hampshire, SO41 8GN, UK
pisces@pisces-conservation.com
www.irchouse.demon.co.uk
www.pisces-conservation.com
Phone: 44 (0) 1590 674000
Fax 44 (0) 1590 675599

316(b) Existing Facilities Rule EPA 821-R-11-002 March 28, 2011). Features they list that have been shown to be affected by thermal pollution include;

- photosynthetic,
- metabolic rates
- growth rates
- reduce levels of dissolved oxygen
- alter the location and timing of fish behavior including spawning, aggregation, and migration
- thermal shock-induced mortality for some species

The operational differences between once-through cooling systems and closed-cycle cooling systems will significantly reduce the thermal load of the discharge to surface water. Unlike once-through cooling systems, where the entire thermal load is delivered to the surface water body, in a closed-cycle cooling system, most of the heat is transferred to the air. Thus, irrespective of how the flows are configured, there will be a substantial reduction in the thermal load of the effluent from a closed-cycle system compared to a once through system. The use of cylindrical wedgewire screen will not affect the thermal plume.

2.1 The Plume

The heat in the discharged cooling water is initially dispersed by mixing with the receiving water. As it mixes and usually rises to the surface it spreads out over the surface forming a detectable plume which spreads in the direction of the prevailing current. The initial drop in water temperature is almost entirely due to mixing with the receiving water. Some heat will be lost from the surface of the plume to the air, but close to the discharge the surface area from which the heat can be dispersed to air is small so the majority of the heat is dispersed by mixing.

The direction of dispersal and ultimate shape of a discharge plume is determined by the ambient current. Water movement in the vicinity of Indian Point is dominated by tidal forces as reported in *Analysis of Near-Bottom Flow in the Hudson River at Indian Point Energy Center from Data Collected by Acoustic Doppler Current Profilers 4 March through 2 November 2010* prepared by Normandeau Associates, Inc. Both the direction and speed of the current varies tidally and seasonally. On the flood tide the current direction is predominately north easterly and on the ebb tide south westerly. On p 6 it states *"Current speeds at all four fixed ADCP Stations exceeded 0.25 fps at least 80% of the time, 0.50 fps at least 63% of the time, 0.75 fps at least 49% of the time, 1.00 fps at least 35% of the time, and 2.00 fps at least 7% of the time for the entire monitoring period from 4 March through 2 November 2010 (Table 7)."* The result of these variations is that the plume swings with the tide and the shape changes over the tidal cycle. Further, there will also be spring-neap and seasonal changes in currents which will affect the shape of the plume.

The depth of the plume will also change over time depending on several factors such as the current passing the outfall and the salinity and temperature profile of the river. The FEIS (2003) data from HydroQual, 1999 shows that there may be times and conditions when the effluent-warmed waters occupy nearly the entire vertical water column. For example at every slack tide (which occurs about 4 times per day) the warm water will pool and would be much deeper.

Because the plume changes in direction and shape the location of the mixing zone and the region with elevated temperatures changes constantly. The effect is that a larger area of river is regularly within the mixing zone and subject to thermal impacts, than would be the case with a discharge on a river with a constant directional flow.

Entrainment of plankton in thermal discharge plumes is a normal and unavoidable occurrence. As the jet of heated cooling water is released from the plant it entrains the receiving water into the jet and mixes. This mixing of the heated water discharged from the power plant and receiving water creates a larger more diffuse area of warmed water. Organisms, including fish eggs and larvae, are entrained in this flow of warm water and become impacted by the sudden rise in temperature.

2.2 The discharge temperatures

The average maximum temperatures of the discharge for each calendar month for the years 2000 to 2007 are tabulated below. Note that for the summer months the maximum is regularly in excess of 90 *degrees* Fahrenheit, further, there are occasions when the temperature exceeds 100°F; this is a temperature at which many aquatic organisms living in the estuary will suffer acute harm or death (see Effects of temperature on the organisms in the Hudson, below).

Figure 1 shows a plot of the maximum daily discharge temperatures at Indian Point with the 90° and 100°F reference temperatures shown in red. Note that 90°F, a temperature that is known to be lethal to some aquatic organisms, has been exceeded for extended periods every summer since 2001. Furthermore, 100°F has been exceed in 3 of the 7 summers for which data are plotted.

Table 1: The average maximum discharge temperature (°F) of the Indian Point cooling water discharges for the years 2000 to 2007. Missing numbers are months for which no data are available. (Indian Point Daily Temperature Reports 2000-07)

Month	2000	2001	2002	2003	2004	2005	2006	2007
1	66.38	57.35	70.53	68.45	70.78	70.74	74.78	70.25
2	63.63	67.61	69.76	65.41	69.57	71.88	71.39	67.76
3	64.08	70.57	69.91	65.20	70.46	69.17	69.59	63.29
4	70.05	71.52	74.75		71.89	72.86	75.54	
5	77.01	78.07	79.85		82.64	81.92	79.82	
6	79.40	88.82	86.41		**91.81**	**92.08**	89.17	
7	88.66	**97.27**	**98.29**	**96.68**	**97.21**	87.89	**96.95**	
8	89.19	***100.01***	***101.29***	**96.45**	**97.21**	***103.58***		
9	86.83	**96.11**	**94.91**	**94.38**	**90.27**	**99.66**	**94.24**	
10	80.62		85.24	82.56	81.88	83.89	85.34	
11	75.87		68.06	78.00	76.52	77.68		
12	64.05		73.23	74.30	73.95	75.50	77.25	

Pisces Conservation Ltd
IRC House, The Square
Pennington, Lymington
Hampshire, SO41 8GN, UK
pisces@pisces-conservation.com
www.irchouse.demon.co.uk
www.pisces-conservation.com
Phone: 44 (0) 1590 674000
Fax 44 (0) 1590 675599

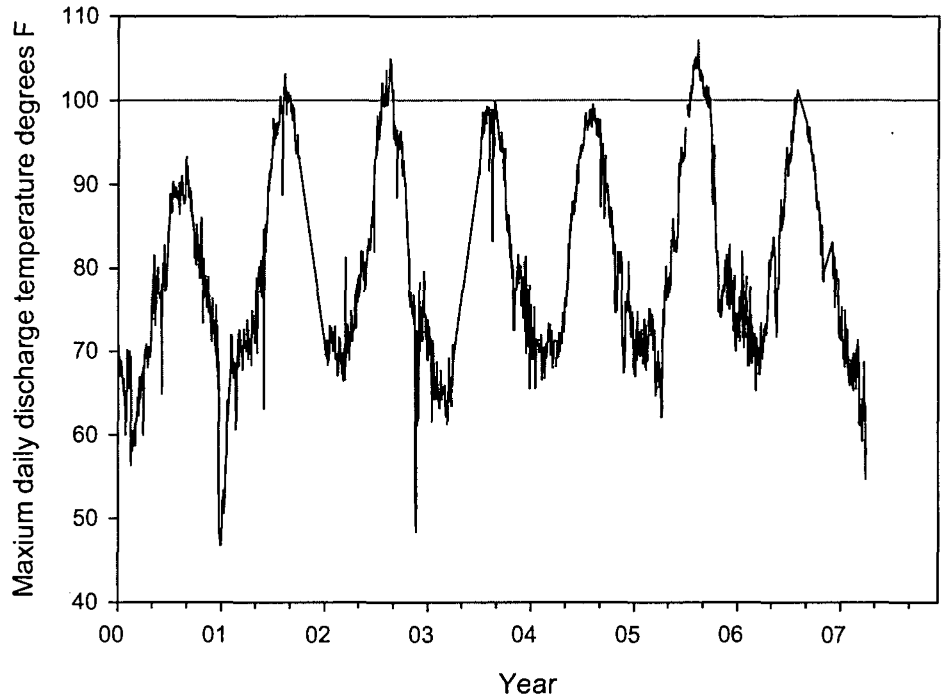


Figure 1: Plot of the maximum daily discharge temperatures at Indian Point 2000-2007. The 90° and 100°F reference levels are shown in red.

2.3 *The size of the plume*

There is no discrete boundary around a thermal plume. The plume loses temperature as it mixes with the ambient waters and releases heat to the atmosphere. Temperature constraints are set at defined isotherms. Water quality standards have two different limits (1.5°F or 4°F) for the delta F (temperature rise) above ambient. This plume (either the one defined by 1.5°F or 4°F) is then accessed as to whether it spreads across to much of the waterbody. The two different temperature definitions area based on the ambient temperature of the river. If during July, August and September the ambient temperature is over 83°F then the allowable plume increment is 1.5°F, while if the ambient temperatures are below 83°F then the allowable plume increment is 4°F.

In the ASA (2010) study the maximum defined ambient temperature was below 83°F (ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge page ii) (for example on the 10th July it was between 80 and 81 °F – figure 5-5). So the delta 4 °F rule (as less than 83 °F Background) was modelled. In Figure 3A (Figure 7-1 and 7-2 from ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge) the modelled 4 °F isotherm plume is shown at maximum extent to reach approximately 2.2 miles downriver into Haverstraw Bay. This plume spreads about 0.2 miles across the river – this gives a very approximate area of 1536 acres. If the 1.5 °F rule was in place the plume would need to be diluted approximately 2.6 times more, which would require a much larger area. The size of the plume can be

In addition to the effect of the Indian Point discharge in isolation, its impact in combination with that of other thermal inputs needs to be considered. The Massachusetts Institute of Technology dynamic network model was reported in the DEIS for a range of power plant discharge scenarios. A typical output is presented in Figure 2. In this graph the lower line (line 1) represents the ambient temperature of the estuary. The top line (line 5) represents the effect of all the thermal discharges in combination. The line labelled 3 is the temperature rise in the estuary excluding the thermal discharge from Indian Point. A comparison of lines 3 and 5 show the appreciable effect of Indian Point generating station, which was predicted to increase river temperature by > 1°F for more than 10 miles of estuary. Note that the plume of Indian Point also combined with the thermal pollution from other sources.

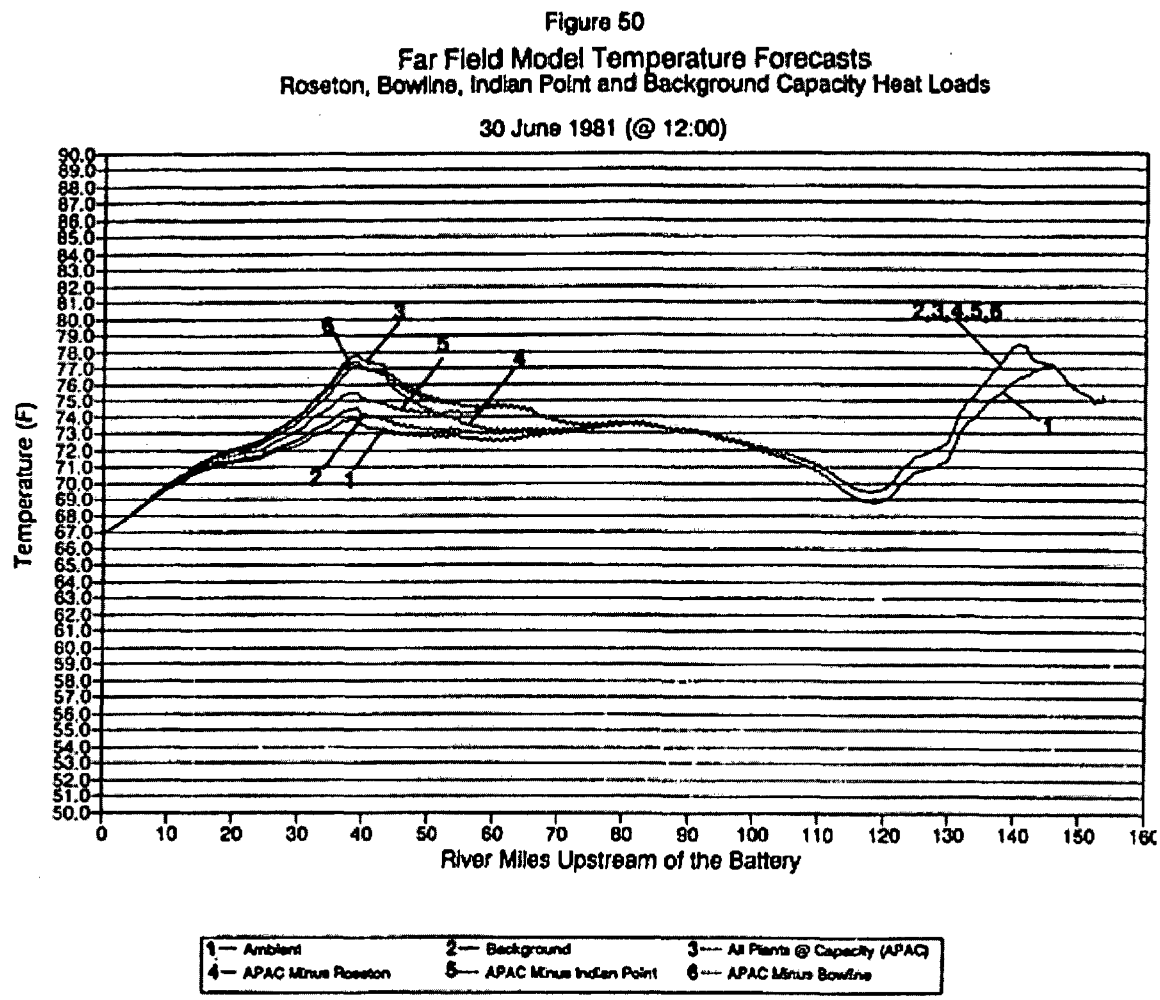


Figure 2: A sample of the results presented for the far field temperature effects of the Hudson Estuary power plants. From the DEIS for Roseton, Bowline and Indian Point generating stations.

In Figure 3B the observed plume (bounded by a 4°F isotherm) is summarised; the plume here is about 1mile long and about 0.2 miles wide.

A B

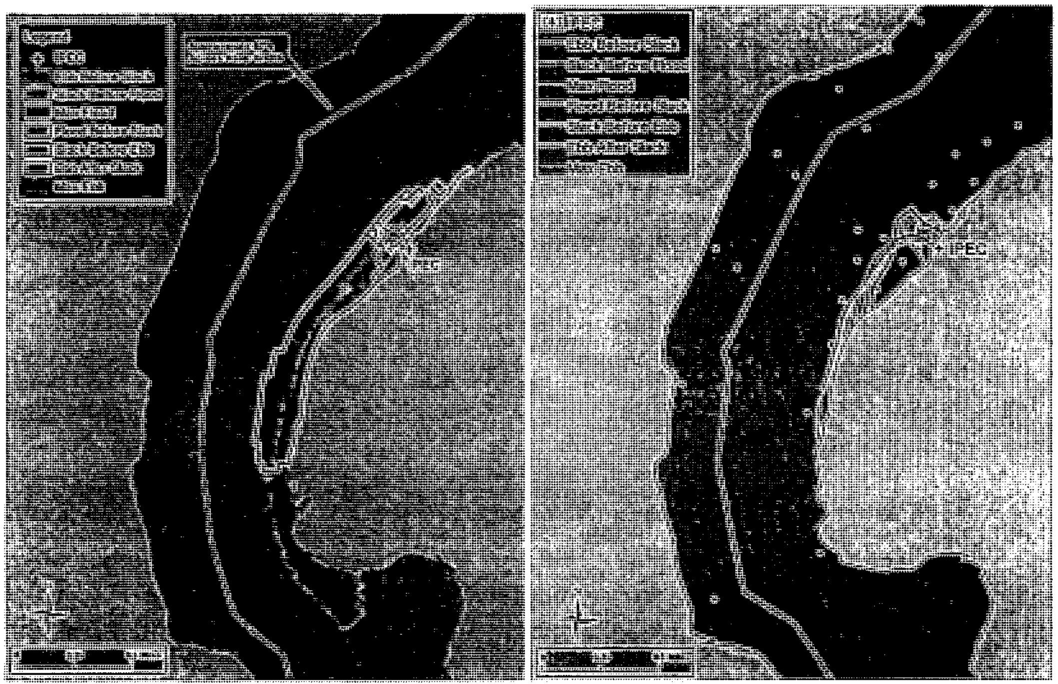


Figure 3: A Figure 7-1 Extent of the 4°F plume over a tidal cycle using model predictions. B Figure 7-2 Extent of the 4°F plume over a tidal cycle using contoured observed temperatures with modeled ambient subtracted

During the ASA 2010 study, the area within the 90°F isotherm, an area where lethal conditions exist for aquatic life, was found to be about 14 acres during the ebb and about 4 acres during the flood tide (ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge page 106 Figure 5.2), this area will kill fish and other organisms that are entrained into it. This is about 9 °F above ambient. This is obviously much smaller than the actual size of the plume as shown in Figure 4.

Pisces Conservation Ltd
IRC House, The Square
Pennington, Lymington
Hampshire, SO41 8GN, UK
pisces@pisces-conservation.com
www.irchouse.demon.co.uk
www.pisces-conservation.com
Phone: 44 (0) 1590 674000
Fax 44 (0) 1590 675599

Figure 4: The extent of the thermal plume from the cooling water discharge of Indian Point Unit 3, and the Lovett generating station.

Infrared images highlight the surface extent of the thermal plume released from Indian Point (Figure 4). The image below, taken from the FEIS, shows the high proportion of the width of the river that is impacted by the Unit 3 discharge of Indian Point. The following quotation describes the concern:

"The surface extent of thermal discharges from the HRSA plants is also a concern. Figure 8 is an aerial thermal image of the plume from Indian Point, Unit 3 only, on the east side of the Hudson plus the smaller plume from Lovett on the west bank. In this image, the two plumes came very close to meeting on the surface, even with Indian Point running at less than its full capacity." (FEIS, Chapter 5 p 71)

In summary, the surface extent of the thermal plume produced by Indian Point covers a high proportion of the width of the river.

2.4 Effects of temperature on the organisms in the Hudson

Almost all aquatic life is affected by thermal discharges. The effects of temperature on the biology and ecological requirements of fish have been extensively studied and reviewed. Temperature can affect survival, growth and metabolism, activity, swimming performance and behaviour, reproductive timing and rates of gonad development, egg development, hatching success, and morphology. Temperature also influences the survival of fishes stressed by other factors such as toxins, disease, or parasites. Many of these effects will occur well below the upper lethal temperatures which are given below. It can be seen from this table that many species will die in waters over 90°F.

Table 4: Upper tolerance temperatures for some species of Hudson fish. (Acclimatization is the temperature the fish is used to before being exposed to hot water). (Multiple sources: particularly Langford (1990)).

Species	Latin Name	Acclimatization temperature		Upper tolerance limit	
		ºC	°F	ºC	°F
Carp	*Cyprinus carpio*	20	68	31-34	87.8-93.2
Large mouth bass	*Micropterus salmoides*	20	68	32.5	90.5
		30	86	36.4	97.52
Blue gill	*Lepomis macrochirus*	15	59	30.7	87.26
3 spined stickleback	*Gasterosteus aculeatus*	25-26	77 – 78.8	30.6	87.08
Yellow perch	*Perca flavescens*	15	59	27.7	81.86
Alewife	*Alosa pseudoharengus*	15	59	23	73.4
Rainbow smelt	*Osmerus mordax*			21	69.8
Sea lamprey	*Petromyzon marinus*			34	93.2
Tomcod	*Microgadus tomcod* 2 cm			19-20.9	66.2-69.62
	14-15 cm			23.5-26.1	74.3-78.98
	22-29 cm			25.8-26.1	78.44-78.98
Common shiner	*Notropis cornutus*	15	59	30.3	86.54
Brown bullhead	*Ictalurus nebulosus*	15	59	31.8	89.24
Striped bass (temperature when mortalities start)	*Morone saxatilis* yolk sac			26	78.8
	Post yolk sac			30	86
	Early juveniles			34	93.2
American shad	*Alosa sapidissima*			28	82.4
White perch	*Morone americana*			32-34	89.6-93.2

Generally young and small fish are more vulnerable to elevated water temperatures than adults. Maximum summer temperature of the Hudson River in the vicinity of Indian Point is over 81 °F

(27.2 °C). Most of the fish in the Hudson can just tolerate the maximum summer temperature although for some such as the tomcod it is too hot and they must seek cooler waters (for example head towards the ocean).

Several studies have shown that species diversity of phytoplankton decreases in areas consistently heated to over 30 °C (mid 80s °F). When water temperatures reach 35 – 38 °C (95-100 °F) zooplankton abundance declines and mortalities occur. Effects on benthic invertebrate life are also possible because of the depth that the warm water plume can reach.

At some states of the tide the discharge plume will attach to the bank of the estuary. When this occurs, the more productive shallows and their associated benthos will be affected by thermal pollution.

During the 3 months of the ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge survey, the discharge temperatures ranged from 94°F to 103°F (page 62). The delta T was a mean of 17.17°F and a maximum of 18.8°F. Accordingly, these temperatures would cause lethal conditions of organisms entrained into the thermal plume. Thermal effect extends considerably beyond any mixing zone. For example the Massachusetts Institute of Technology dynamic network model was reported in the show the appreciable effect of Indian Point generating station, which was predicted to increase river temperature by > 1°F for more than 10 miles of estuary.

2.5 Effects on a balanced, indigenous population of fish, shellfish and wildlife in the Hudson.

In the discussion above it was noted that many species are undergoing major changes in abundance. If by balance we mean the populations are stable this cannot be the case.

Henderson and Seaby (2000) state "Large temporal changes in fish species abundance together with a small decrease in total species richness and diversity suggest that the Hudson estuary ecosystem is far from equilibrium. There is a small long-term decline in both species richness and diversity within the fish community. These losses are not confined to rare or infrequent visitors. A number of common or once abundant fish have long-term trends of declining abundance including tomcod, Atlantic sturgeon, bluefish, weakfish, rainbow smelt, white perch and white catfish. The rate of decrease in abundance of a number of these species is in their range of 5-8% per annum. If these trends were to continue, they will quickly result in profound changes in the fish community.

Cold water loving species such as the tomcod are close to their upper thermal tolerance, so that any increase in river temperature will introduce a stress that will contribute to their observed decline.

Pisces Conservation Ltd
IRC House, The Square
Pennington, Lymington
Hampshire, SO41 8GN, UK
pisces@pisces-conservation.com
www.irchouse.demon.co.uk
www.pisces-conservation.com
Phone: 44 (0) 1590 674000
Fax 44 (0) 1590 675599

3 The problems with the mixing zone as contained in the new draft SPDES permit condition

The DEC Proposes to allow the station a 75 Acre mixing zone to encompass the area of the discharge where thermal and numerical standards cannot be met. The suggested rule is.

"b.. The thermal discharge from the Indian Point nuclear facilities shall assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on the Hudson River. In this regard, the Department has approved the permittee's request for a thermal discharge mixing zone pursuant to 6 NYCRR section 704.3 for the 5-year term of this SPDES permit. The water temperature at the surface of the Hudson River shall not be raised more than 1.5 degrees Fahrenheit (from July through September, when surface water temperature is greater than 83 degrees Fahrenheit) above the surface temperature that existed before the addition of heat of artificial origin (6 NYCRR section 704.2[b][5][iii]) except in a mixing zone of seventy-five (75) acres (total) from the point of discharge. The thermal discharge from the Indian Point nuclear facilities to the Hudson River may exceed 90 degrees Fahrenheit (6 NYCRR section 704.2[b][5][i] of the State's Criteria Governing Thermal Discharges) within the designated mixing zone area, the total area of which shall not exceed seventy-five (75) acres (3,267,000 square feet) on a daily basis."

In the analysis document supplied (Alternative Mixing Zone Explanation – 3 May 2011) the estimated size of the mixing zone was determined by estimating the maximum area of the plume at 89°F (as there is a 1°F margin of predictive tolerance model).

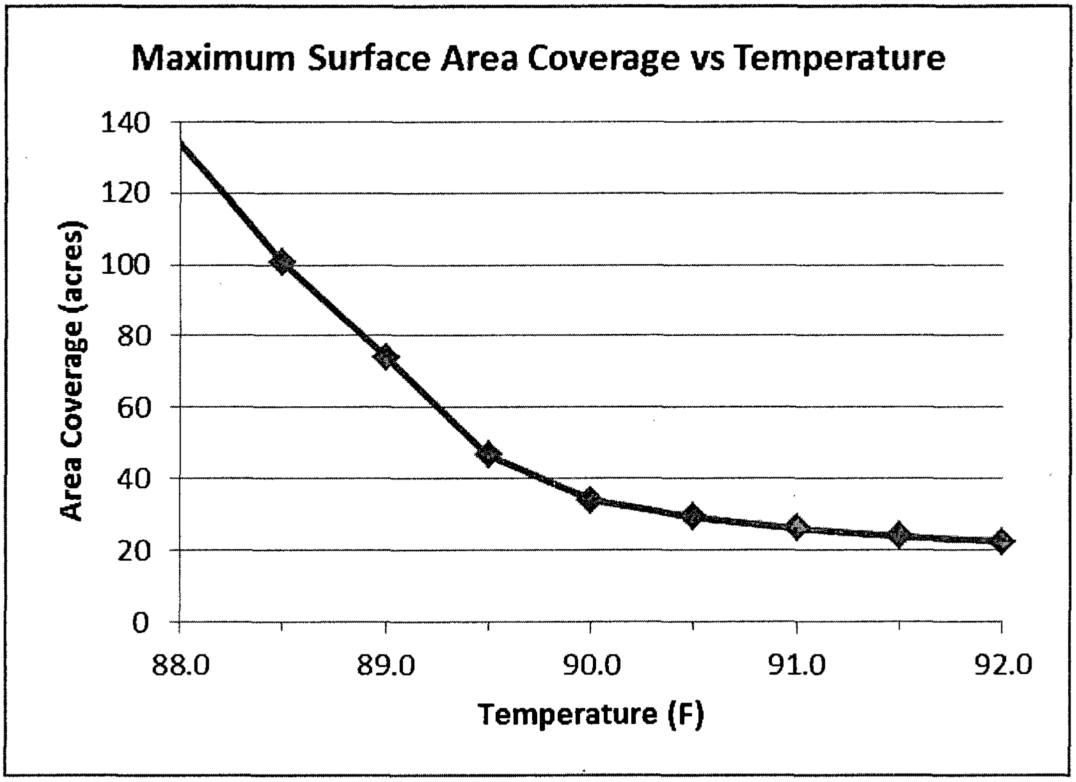


Figure 5. Maximum surface area coverage as defined by surface temperature – Note that at 89°F the area is about 75 Acres.

This is the area defined from the "extreme scenario" and is therefore unlikely to occur. It is unclear whether these 75 acres represent the swept area of the plume or the maximum extent at any one time. This equates to an area of over 68 American football pitches where the water temperature is allowed to exceed 90°F. As the plume attaches to the shore it effectively means that for 1.69 miles downstream and 0.7 miles upstream the banks could be bathed in water that is hot enough to damage and kill the littoral organisms (Table 2 below). Even under typical conditions over a mile of the important littoral habitats (+/- 0.5m miles in each direction) will be swept by water which could be over 90°F and can be over 100°F (page 92, ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge section 4.2.4.2) and could be lethal to organisms exposed into it. As the plume will move in response to the tidal conditions (see section 8.1 The Plume), areas within the mixing zone will undergo very large daily temperature variations.

Table 2: Maximum and typical extent of thermal plume mixing zone in downstream and upstream directions. (Alternative Mixing Zone Explanation – 3 May 2011)

	Maximum Extent		Typical Extent	
	Distance (ft)	Distance (mi)	Distance (ft)	Distance (mi)
Downstream	8,900	1.69	3,000	0.57
Upstream	3,700	0.71	2,800	0.53

4 Other Issues

4.1 Climate Change

Water temperatures in the Hudson are increasing. This is clearly demonstrated by the statistically significant increase in mean average annual water temperature measured at Poughkeepsie Water Treatment Facility which was recently analysed in detail by Seekal and Pace (2011)[4]. They found that the Hudson River has warmed by 0.945 °C since 1946. The mean annual temperature in recent years is about 2°C (3.6°F) above that recorded in the 1960s. The rising trend is illustrated in Figure 6 below.

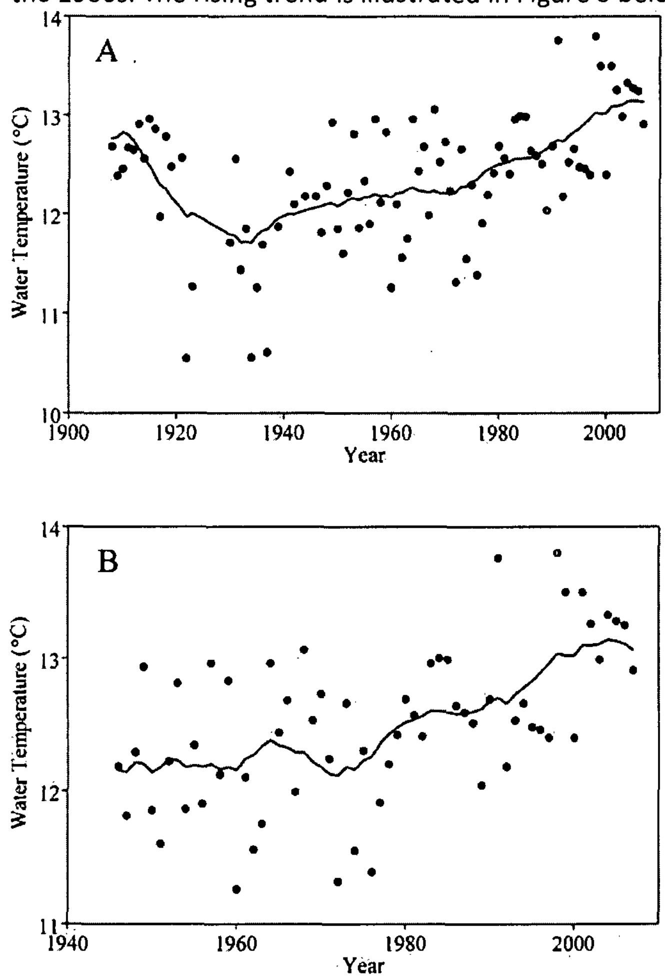


Figure 6: Average annual water temperature (°C) as measured at Poughkeepsie's Water Treatment Facility, A) 1908 to 2007 and B) 1946 to 2007. The trend lines are locally weighted regressions. Reproduced from Seekal and Pace (2011)[5]

[4] Seekal, D. A. & Pace, M.L. (2011) Climate change drives warming in the Hudson River Estuary, New York (USA). Journal of Environmental Monitoring. DOI: 10.1039/c1em10053j

[5] Seekal, D. A. & Pace, M.L. (2011) Climate change drives warming in the Hudson River Estuary, New York (USA). Journal of Environmental Monitoring. DOI: 10.1039/c1em10053j

Examination of the daily temperatures for 2005 plotted against the mean, minimum and maximum temperatures from 1951 to 2004, show that the temperature for several summer months in 2005 was close to the maximum ever recorded (see Figure 7). However, in the winter, it also reached some of the lowest temperatures recorded over a 53 year period. In summary, the temperature regime is becoming more extreme.

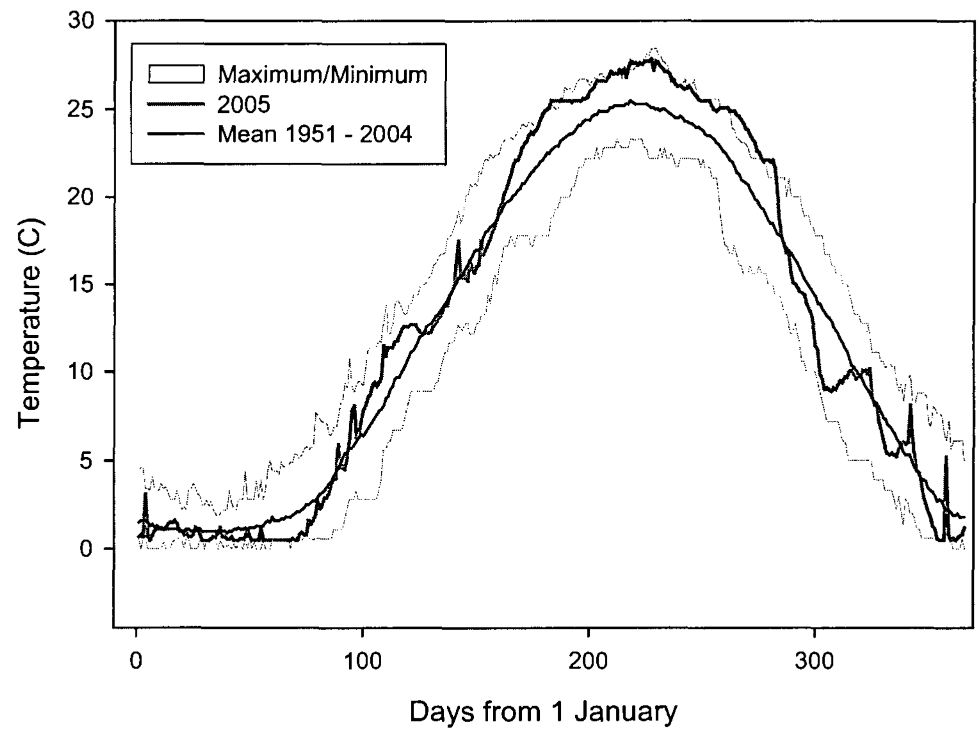


Figure 7: Poughkeepsie Water Treatment Facility data; mean, minimum, and maximum temperature (°C) for each day of the year, 1951 to 2004, with 2005 data plotted in red. – Data from 2005 Year Class Report – Appendix B Table B - 5.

We can conclude that with current trends the river in the vicinity of Indian Point even with no thermal input will certainly break the 83 °F threshold soon. Further, this threshold will certainly be breached during a summer heat wave in August.

4.2 Ambient temperature is incorrectly evaluated

A key issue relates to the potential of the river during summer to exceed an ambient temperature of 83 °F. In the ASA (2010) report the **predicted** ambient temperature with **no** thermal discharge from **any** plant was 82.2 °F (p 109). This value (82.2°F) was calculated for the period 8 to 30 July 2010.

The assertion that ambient temperature never exceeds 83 °F is wrong:

The surface ambient temperature reached a maximum of 82.2°F, always under the 83°F threshold where the allowable plume temperature rise is limited to 1.5°F versus the 4°F. Therefore, only the spatial extent of the cross sectional area and surface width of the 4°F were calculated to determine compliance.
(ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge, page 118, section 6.3. para 3)

The following arguments show this to be the case.

- The river is known to exceed 83 °F at Poughkeepsie water works. To get examples of temperatures above 83 °F (28.33°C) examine the water temperatures recorded in Appendix B of the year class reports. For example the maximum temperature observed between 1951 and 2008 was above 83°F in August.
- Note that **all** the observations at Poughkeepsie for temperatures over 83 °F are recorded for August. ASA used July data for their modelling, this is not the month with the highest recorded water temperatures.
- The maximum ambient temperature claimed by ASA (2010) is a modelled value not a recorded value. To reach this value they have attempted to remove the thermal inputs from all thermal discharges. However, the temperature of the estuary is known to be raised generally by thermal discharges so it is inevitable that the water will be warmer than their value. In practice, the ambient temperature has to be the actual ambient water temperature observed not a hypothetical value as if there were no thermal pollution.

4.3 *Worst Case incorrectly analysed*

Section 5.2.3 ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge states that as the ambient temperature was below the threshold for the 1.5°F (i.e. 83°F) during the time of the survey, the model was not run to determine the plume extents for the stricter 1.5°F limit. The thermistor used to determine the ambient temperature (no 27) reached 82.2°F

> *The thermistor station 27 location was used as a proxy for the ambient temperature. The surface ambient temperature reached a maximum of 82.2°F, always under the 83°F threshold where the allowable plume temperature rise is limited to 1.5°F versus the 4°F. Therefore, only the spatial extent of the cross sectional area and surface width of the 4°F were calculated to determine compliance.* (ASA 2010 Field Program and Modeling Analysis of the IPEC Discharge page 118)

Taking into account that the sampling was done before the typical seasonal maximum in August, the likelihood of the climate change, and the variations in summer temperatures it seems highly likely that the 83°F limit will be reached in some years.

The DEC asked for a worst case scenario as shown below

"The conservative approach used by Department staff to predict "worst-case" is the MA7CD10 (7 day, 10 year low flow) and the lowest flow for the available record period, background temperature in the river of 90 degrees Fahrenheit (at "slack ebb begin" and "slack flood begin" tide conditions), and during thermal stratification periods. This was discussed at the meeting on March 22, 2010. Moreover, and as noted in its July 3, 2009 letter to Entergy, the Department requires the model to be run at these critical conditions, and the results compared to the thermal criteria in 6 NYCRR § 704.2. Furthermore, in-stream data must be gathered during July-September critical periods and used to verify correct calibration of the model. All predictions are to be performed at All Plants at Capacity (APAC) conditions."
NYDEC April 2, 2010 401 Denial at 12

By not considering the correct "worst case" scenario the impacts are understated.

4.4 Bank Attachment

The plume as modelled by ASA (2011) attaches to the bank for a considerable distance downstream, and to a considerable depth. As shown by the isotherms in the images Below, and the infrared images highlighting the surface extent of the thermal plume released from Indian Point in Figure 4, the plume spreads a considerable distance across the river.

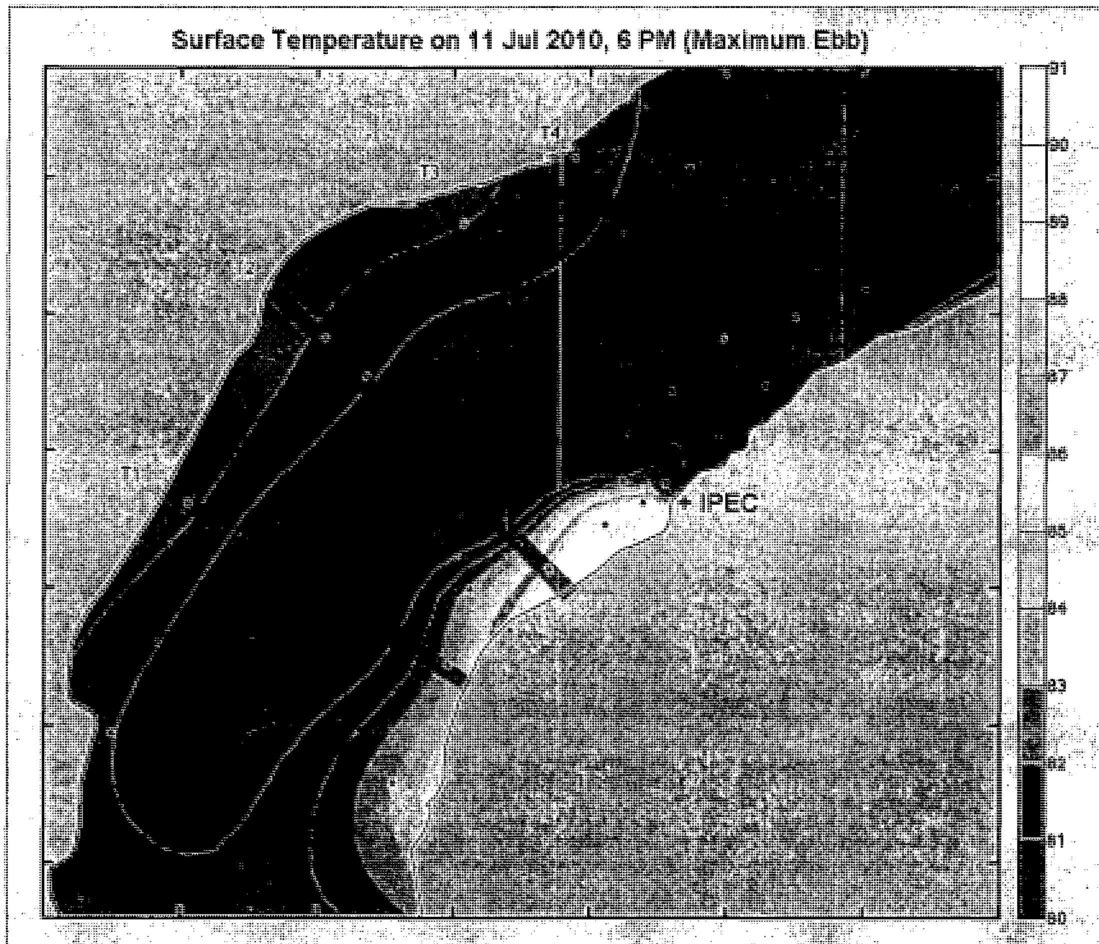


Figure 8: Figure 1-2. Plan view of surface temperatures near IPEC on 11 July 2010 at 1800 during maximum ebb. Color scale (in degrees F) shows the interpolated horizontal temperature distribution.

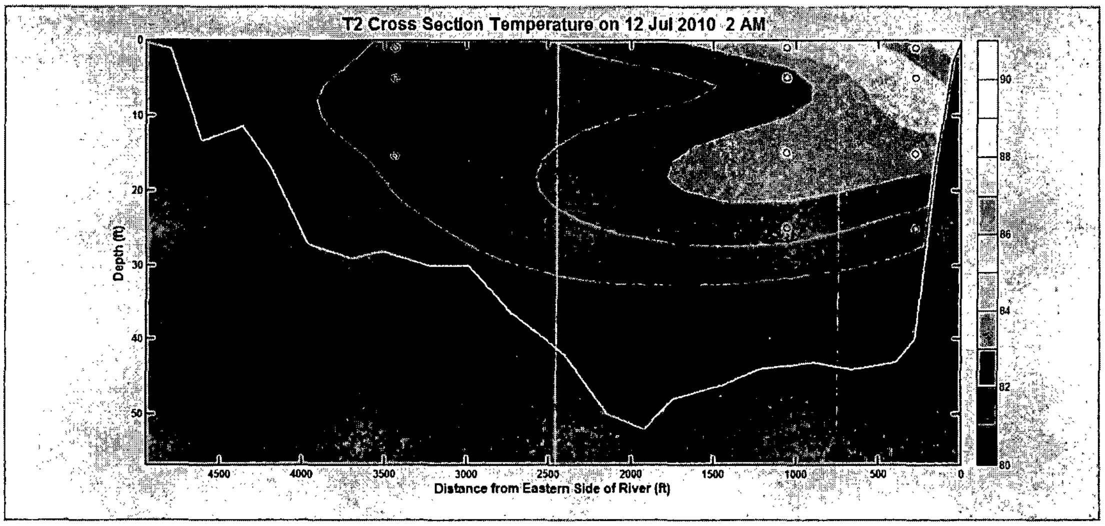


Figure 9: Figure 1-14. Vertical section of temperatures at T2 transect on 12 July 2010 at 0200 during slack before ebb. Color scale (in degrees F) shows the interpolated vertical temperature distribution.

Docket ID NRC-2008-0672

Attachment B

to

Riverkeeper, Inc.'s Comments on the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50–247 and 50–286 (June 2012)

RIVERKEEPER.

July 15, 2011

<u>**VIA U.S. MAIL**</u>
<u>**AND E-MAIL to depprmt@gw.dec.state.ny.us**</u>
Christopher M. Hogan
NYSDEC Headquarters
625 Broadway
Albany, NY 12233
depprmt@gw.dec.state.ny.us

Re: *Entergy Nuclear Indian Point 2, LLC & Entergy Nuclear Indian Point 3, LLC Proposed Modification of Special Condition 7.b of SPDES Permit, DEC No.* 3-5522-00011/00004, SPDES No. NY-000472

Dear Mr. Hogan:

Riverkeeper, Inc., the Natural Resources Defense Council (NRDC) and Scenic Hudson Inc., (collectively hereinafter "Riverkeeper") hereby respectfully submit the following legal comments and accompanying technical comments of even date, along with Riverkeeper's October 2007 technical comments entitled "Comments on Entrainment, Impingement and Thermal Impacts at Indian Point Nuclear Power Station" (October 2007) (both sets of technical comments being collectively hereinafter "Riverkeeper's technical comments") on the above-referenced Application of Entergy Nuclear Operations, Inc. ("Entergy") under ECL Article 17, Titles 7 & 8 in connection with the tentative determination of the New York State Department of Environmental Conservation (NYSDEC) to modify[1] Special Condition 7.b of the above-referenced 2004 draft SPDES permit to allow for a 75-acre thermal mixing zone (hereinafter the "Thermal Modification"), as noticed in NYSDEC's Environmental Notice Bulletin ("ENB") issued on June 15, 2011.

Entergy seeks a SPDES permit to withdraw 2.5 billion gallons of cooling water per day from the Hudson River and discharge a nearly-equal amount of unabated heated effluent to the Hudson River while operating the Indian Point Nuclear Electric Generating Facility (the Facility) in

[1] Although the June 15, 2011 notice styles the NYSDEC action as a tentative determination to "modify" the existing draft 2004 SPDES permit, Riverkeeper notes that a "modification" under 6 NYCRR § 621.2(t) is defined as modification as "any change or amendment whatsoever to a permit that is currently in force, including permit transfer." Since the proposed Thermal Modification is actually a revised draft permit term, the limitations of 6 NYCRR § 750-1.18(d) are not applicable to these comments.

20 Secor Road Ossining New York 10562 • 914.478.4501 • f: 914.478.4527 • www.riverkeeper.org

once-though cooling mode, as the Facility has operated for roughly the last thirty five (35) years. But the Clean Water Act's antidegradation policy and requirements for the application of the stricter of technology or water quality based effluent limitations mandate otherwise. Moreover, the Thermal Modification's proposed mixing zone is similarly inconsistent with the Clean Water Act and state law. Since the proposed mixing zone is illegal, the discharge will continue to violate thermal (and other) water quality standards and impair the designated uses of the receiving water. Since the discharge violates effluent limitations and water quality standards, Entergy would need to seek a variance under Section 316(a) of the Clean Water Act and 6 NYCRR § 704.4. Additionally, since the thermal discharge does not comply with effluent limitations or water quality standards and impairs designated and existing uses, a compliance schedule including interim measures to minimize pollution is required pursuant to 6 NYCRR § 750-1.14(a).

NYSDEC has recognized the inseparable connection between the Facility's cooling water intake and thermal discharge and has required closed-cycle cooling based on adverse environmental impacts associated with the Facility's cooling water intake. Accordingly, Riverkeeper's Petition for Party Status dated July 10, 2010 and NYSDEC's April 2, 2010 Denial of Entergy's Request for a CWA § 401 Water Quality Certification are hereby incorporated by reference and Riverkeeper requests that the legal and technical points raised by these comments be considered in the light of the cumulative and synergistic effects of the Facility's cooling water intake impacts. That being said, Riverkeeper respectfully submits that the Facility's thermal discharge also independently requires the imposition of closed cycle cooling by NYSDEC as a SPDES condition.

Accordingly, Riverkeeper respectfully requests that NYSDEC hold an adjudicatory hearing in connection with the proposed Thermal Modification, since Riverkeeper's comments herein raise substantive and significant issues relating to Entergy's application.[2] The resolution of the issues raised herein may result in denial of the Thermal Modification, or the imposition of significant conditions thereon.[3]

I. The Commenter's Respective Interests

a) Riverkeeper's Interest

Riverkeeper is a not-for-profit organization dedicated to protecting the ecological integrity of the Hudson River.[4] Since its inception in 1966, Riverkeeper has used litigation, science, advocacy, and public education to raise and address concerns relating to the operation of the Indian Point nuclear power plant. For decades, Riverkeeper has fought tirelessly against Entergy's continued use of an environmentally destructive once-through cooling water system at Indian Point. In more recent years, Riverkeeper has been actively involved in addressing newly discovered

[2] 6 NYCRR § 621.8(b).

[3] 6 NYCRR § 621.8(b).

[4] *See* Riverkeeper.org, Our Story, http://www.riverkeeper.org/ourstory_index.php (last visited July 15, 2011).

accidental leaks of radioactive water to the environment from degraded plant components. As parties in both the license renewal proceeding currently pending before the U.S. Nuclear Regulatory Commission, and in the ongoing Indian Point State Pollutant Discharge Elimination System ("SPDES") permit renewal proceeding and appeal of NYSDEC's denial of Entergy's request for a Clean Water Act § 401 Certification, Riverkeeper continues to play an integral role in addressing such issues.

b) NRDC's Environmental Interest

As a national not-for-profit environmental advocacy organization organized under the laws of New York State and headquartered in New York City, NRDC includes among its principal purpose safeguarding the earth's people, its plants and animals, and the natural systems on which all life depends. The protection of the environment, including the land, air, energy, and water, as well as advocacy to protect aquatic life from adverse impacts from power plants such as harm from cooling water intake structures, remain core functions of its organizational mission. Founded in 1970, NRDC is composed of approximately 1.3 million members, tens of thousands of which live in New York State. NRDC strives to protect nature in ways that advance the long-term welfare of present and future generations by working to foster the fundamental right of all people to have a voice in decisions that affect their environment. Many of NRDC's members engage in fishing, swimming, boating, and other recreational, conservation, education, and aesthetic activities in the Hudson River and the New York Harbor, into which the Hudson River flows.

c) Scenic Hudson's Environmental Interest

Scenic Hudson is a not-for-profit environmental organization and separately incorporated land trust dedicated to protecting and enhancing the scenic, natural, historic, agricultural, and recreational treasures of the Hudson River and its valley. Scenic Hudson was originally founded to oppose the proposed Storm King Mountain pumped storage electrical generation facility. Since its incorporation, Scenic Hudson has been an active participant in efforts to promote environmentally sound development and protection of the Hudson River Valley. Scenic Hudson is dedicated to protecting and restoring the Hudson River, its riverfront and the majestic vistas and working landscapes beyond as an irreplaceable national treasure for America and a vital resource for residents and visitors. Scenic Hudson has approximately 20,000 members from New York State and the nation, a majority who reside in the counties along the Hudson River. Its supporters are regular users of the Hudson River for fishing, boating, swimming, and other activities. Scenic Hudson's interests include protecting and improving the River's water quality and aquatic life.

II. Riverkeeper's Legal Issues

Issue No. 1: *The Thermal Modification Was Issued Without a Fact Sheet*

The Thermal Modification does not include a Fact Sheet (and the 2003 SPDES Fact Sheet has not been amended) and this may limit Riverkeeper's ability to provide sufficiently detailed comments on the modified SPDES permit[5] since the Fact Sheet would set forth, *inter alia*, "the principal facts and the significant factual, legal, methodological and policy questions considered in preparing the draft permit."[6] A Fact Sheet would also include "a brief summary of the basis for the draft permit conditions including references to applicable statutory or regulatory provisions."[7] Riverkeeper accordingly submits these comments without prejudice to its right to supplement or amend these comments if and when NYSDEC issues a Fact Sheet for the proposed Thermal Modification.

Issue No. 2: *The Draft SPDES Permit with the Thermal Modification Violates the Clean Water Act and other Applicable Law Because it Lacks Technology-Based Effluent Limitations for the Facility's Thermal Discharge*

It is the policy of the State of New York to maintain reasonable standards of purity of the waters of the state consistent with. . .the propagation and protection of fish and wild life, including birds, mammals and other terrestrial and aquatic life" and "to require the use of all known available and reasonable methods to prevent and control the pollution of the waters of the state. . ."[8] SPDES permits must ensure, *inter alia* that discharges will conform to and meet the requirements of the Clean Water Act (CWA) and all "rules, regulations, guidelines, criteria, standards and limitations adopted pursuant thereto relating to effluent limitations [and] water quality related effluent limitations. . .[9] Accordingly, SPDES permits must contain applicable effluent limitations as required by the CWA and as may be required by NYSDEC regulations.[10]

The principal purpose of the CWA is "to *restore* and *maintain* the chemical, physical and biological integrity of the Nation's waters."[11] This purpose "is to be achieved by compliance with the Act, including compliance with the permit requirements."[12] Technology-based effluent limitations ("TBELs") provide the minimum required controls for NPDES permits. TBELs are promulgated by EPA as technology-based effluent limitation guidelines (ELGs) which restrict the quantities, rates, and concentrations of certain point-source pollutants.[13] EPA's NPDES regulations provide that "[t]echnology-based treatment requirements under section 301(b) of the

[5] 40 C.F.R. § 124.8; 6 NYCRR § 750-1.9.

[6] 40 C.F.R. § 124.8(a).

[7] 40 C.F.R. § 124.8(b)(4).

[8] ECL § 17-0101.

[9] ECL § 17-0801.

[10] ECL § 17-0809(1); ECL § 17-0811(1).

[11] CWA § 101(a), 33 USC § 1251(a) (emphasis supplied).

[12] *Weinberger v. Romero-Barcelo*, 456 U.S. 305, 313 (1982).

[13] CWA § 301, 33 USC § 1311.

Act *represent the minimum level of control that must be imposed*" in a permit issued under section 402 of the CWA.[14] Where no applicable national ELGs have been set by EPA, a delegated permitting authority sets TBELs using its best professional judgment (BPJ).[15]
CWA § 301(b)(2) requires industrial dischargers to meet "Best Available Technology" (BAT) limits based for non-conventional pollutants (such as rejected heat from the Facility).[16] BAT requires, at a minimum, that technologically available and economically achievable limits be applied to eliminate discharges, or at least provide reasonable further progress towards such elimination.[17] NYSDEC's SPDES regulations similarly require that the provisions of SPDES permits for thermal discharges ensure compliance with BAT.[18] Although the 2003 Fact Sheet which accompanied the 2004 draft SPDES Permit recognized closed-cycle cooling as an "available technology which can substantially reduce the amount of heat discharged" by the Facility,[19] the proposed modified SPDES permit lacks any provision requiring a TBEL for the Facility's thermal discharge.

Issue No. 3: *The Draft SPDES Permit with the Thermal Modification Violates the Clean Water Act and other Applicable Laws because it Lacks Water Quality-Based Effluent Limitations for the Facility's Thermal Discharge*

Water quality-based effluent limitations ("WQBELs") apply over and above TBELs as needed to protect or restore water quality.[20] Thus, where a point source discharges pollutants with even a "reasonable potential" to cause or contribute to violations of state water quality standards (including narrative standards), NPDES permits must include WQBELs.[21] New York law similarly prohibits discharges which cause or contribute to a condition in contravention of the water quality standards[22] and requires WQBELs.[23]

---

[14] 40 CFR § 125.3(a) (emphasis supplied).

[15] *Catskill Mountains Chapter of Trout Unlimited, Inc. v. City of New York*, 451 F.3d 77, 85 (2d Cir. 2006). CWA § 402(a)(1), 33 U.S.C. § 1342(a)(1); 40 C.F.R. § 125.3(c)(2). Since EPA has not issued ELG's for thermal discharges from facilities in the steam electric power generating point source category, NYSDEC must, as threshold matter, utilize BPJ to determine the appropriate technology-based effluent limitations for the Facility's thermal discharge. *See also* 6 NYCRR §§ 750-1.2(a)(14) and 750-1.11(a)(7).

[16] CWA § 301(b), 33 U.S.C. §1311(b); 40 C.F.R. 125.3(a). *See also In re: Dominion Energy Brayton Point, L.L.C. (Formerly USGen New England, Inc.) Brayton Point Station*, 12 EAD 490(NPDES 03-12), *Remand Order*, (Feb. 1, 2006) 2006 EPA App. LEXIS 9, 25-26; 6 NYCRR 750-1.2(a)(10).

[17] CWA § 301(b)(2), 33 U.S.C. § 1311(b)(2).

[18] 6 NYCRR § 750-1.11(a)(3).

[19] November 2003 SPDES Fact Sheet at 4.

[20] CWA § 301(b)(1)(A) and (B), 33 USC § 1311(b)(1)(A) and (B).

[21] 40 CFR § 122.44(d), CWA § 301(b)(1)(C), 33 USC § 1311(b)(1)(C); 6 NYCRR § 750-1.11(a)(5)(i)

[22] ECL § 17-0501.

[23] ECL § 17-0811(5).

As the United States Supreme Court has observed, even a discharger who meets the CWA's minimum technology-based effluent limitations can be "further regulated" via a WQBEL "to prevent water quality from falling below acceptable levels."[24] Thus, any SPDES permit issued by NYSDEC must require "any requirements in addition to or more stringent than" promulgated effluent limitations guidelines or standards which are necessary to achieve water quality standards—that is, WQBELs.[25] Notably, WQBELs are cost-blind, as EPA's Environmental Appeals Board has explained:

> Water quality-based effluent limitations ("WQBELs"), on the other hand, are designed to ensure that state water quality standards are met regardless of the decisions made with respect to technology and economics in establishing technology-based limits.[26]

As is set forth more fully herein and in Riverkeeper's accompanying technical comments, the Facility's thermal discharge causes and/or has the potential to cause and/or contributes to violations of New York's water quality standards.

NYSDEC has not imposed a WQBEL and has not undertaken the requisite analysis in the context of the proposed modification to determine if the Facility's thermal discharge causes, has the reasonable potential to cause, or contributes to a violation of water quality standards. Yet both the owners of the Facility and NYSDEC have previously indicated that the Facility's unabated thermal discharge *does* cause violations of water quality standards.[27] As NYSDEC's counsel noted in a related NRC proceeding:

> the generators' own statements in the 1999 DEIS pointed out that IP2 and IP3 did not meet the State's §704.2 water quality criteria as to all requirements. The DEIS states that lateral (across the River) and cross-sectional (top-to-bottom of the water column) thermal criteria would be exceeded in the vicinity of Indian Point during some months and during full load operating conditions. The effect is that aquatic species could be blocked from migrating through this part of the Hudson River during certain time periods or seasons. Despite the conclusions of the generators' DEIS, the Department does not consider thermal discharge impacts from Indian Point to be negligible. As reflected in the Declaration of

---

[24] *Arkansas v. Oklahoma*, 503 U.S. 91, 101(1992) (internal quotation omitted).

[25] 40 CFR § 122.44(a)(1) and (d)(1).

[26] *In re: Scituate Wastewater Treatment Plant*, (NPDES Appeal No. 04-17) 2006 EPA App. LEXIS 22, 10 (April 19, 2006).

[27] *See In re License Renewal Application Submitted by Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, & Entergy Nuclear Operations, Inc.*, New York State Notice of Intention to Participate and Petition to Intervene, 2007 NRC LEXIS 167, 599-627 (NRC 2007)

> David Dilks, on the basis of the DEIS, the Department understands that thermal discharges from Indian Point already violate water quality criteria. This is reflected in the Department's draft SPDES permit conditions that require Entergy to conduct a "triaxial survey", a water temperature study, to support the Department's understanding of the contemporary condition of the Hudson River as effected by thermal discharges from IP2 and IP3.[28]

NYSDEC's technical consultant similarly opined that as of November 28, 2007, all technical analyses conducted related to the thermal discharges from the Facility "clearly indicate[d] that the discharges [did] not meet New York State water quality criteria."[29] Riverkeeper's accompanying technical comments illustrate Riverkeeper's scientific disagreement with Entergy over whether Entergy's tri-axial thermal study demonstrates that the Facility's thermal discharge does not *cause* a violation of water quality standards. But the Clean Water Act requires NYSDEC to find that the Facility does not cause, have a reasonable potential to cause, or contribute to a violation of water quality standards.[30]

As recently as 2007, NYSDEC's consultant opined that the Facility, *operating alone*, violated the thermal criteria for estuaries found in 6 NYCRR § 704.2(b)(5)(ii): "Where the criteria require that a minimum of one-third of the surface shall not be raised more than four Fahrenheit degrees, model results indicate that 100% of the surface width will be raised by more than four degrees (i.e., 0% of the surface width will not be raised) during certain tidal conditions."[31] When he considered the Facility's discharge in conjunction with other thermal discharges, NYSDEC's consultant opined that "the extent of criteria violation increases substantially."[32]

The 2003 SPDES Fact Sheet similarly recognized that the Facility's thermal discharge violates water quality standards[33] and indicated that the draft SPDES permit would require a tri-axial thermal study.[34] Nothing further in the record, aside from the letter submitted on behalf of NYSDEC staff dated May 16, 2011, is provided in terms of NYSDEC's conclusions as to whether the discharge causes, has the reasonable potential to cause, or contributes to a violation

---

[28] *Id.* at *720, Declaration of William Little, Esq., ¶ 37.

[29] *Id.* at *601, Declaration of David W. Dilks, ¶3.

[30] 40 C.F.R. § 122.44(d)(1)(i).

[31] *In re License Renewal Application Submitted by Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, & Entergy Nuclear Operations, Inc.*, New York State Notice of Intention to Participate and Petition to Intervene, 2007 NRC LEXIS 167, 610 (NRC 2007), Declaration of David W. Dilks, ¶19.

[32] *Id.* at ¶ 20.

[33] November 2003 SPDES Fact Sheet at 8.

[34] *Id.* at 7.

of water quality standards. NYSDEC simply appears to adopt the conclusions of Entergy's tri-axial study without any independent analysis.[35]

But there are a number of problems with Entergy's tri-axial thermal study, as is set forth more fully in Riverkeeper's accompanying technical comments. The tri-axial thermal study is based on a number of faulty assumptions, including, without limitation, a failure to sufficiently consider the Facility's discharge in conjunction with other thermal discharges. Entergy's tri-axial thermal study declined to consider the full thermal loading conditions of "all plants at capacity" as NYSDEC had requested.[36] But NYSDEC's regulations require consideration of a particular discharge in the context of all other thermal discharges by requiring reference to "the temperature that existed before the addition of heat of artificial origin. . ."[37] Heat of artificial origin, in turn, is defined as "*all heat from other than natural sources, including but not limited to cumulative effects of multiple and proximate thermal discharges*."[38] The regulations clearly require the consideration of *all heat* (not just power plants running at below capacity) from other than natural sources. Riverkeeper's accompanying technical comments illustrate this and other deficiencies in Entergy's tri-axial thermal study.

Moreover, even if NYSDEC could somehow delegate its obligation to analyze the discharge's compliance with New York and federal law to Entergy (which it clearly cannot), Entergy's tri-axial thermal study neither includes nor is based upon an analysis of whether the thermal discharge has the reasonable potential to cause or contribute to a violation of water quality standards when considered in conjunction with "all heat from other than natural sources," including, without limitation, the effects of other thermal discharges and the heated, uncontrolled stormwater discharges which run off from the Facility's acres of impervious surfaces[39] (as well as other sources of stormwater).

In order to determine whether the discharge has the reasonable potential to cause an excursion above a water quality standard, NYSDEC must use all relevant and available data (including facility-specific effluent monitoring data) and employ procedures which account for existing controls on *point and non-point sources* of pollution and the variability of the pollutant or

---

[35] Indeed, Entergy declined to even conduct the analysis under the worst-case scenarios requested by NYSDEC staff, i.e., "under MA7CD10 (7 day, 10 year low flow) and the lowest flow for the available record period, background temperature in the river of 90 degrees Fahrenheit (at "slack ebb begin" and "slack flood begin" tide conditions), and during thermal stratification periods. . .and at [a]ll *predictions are to be performed at* All Plants at Capacity (APAC) conditions." NYSDEC April 2, 2010 401 Denial of Water Quality Certification at 12.

[36] March 29, 2011 ASA Part 1 Response to NYSDEC Staff review of 2010 Thermal Field Program and Modeling Analysis at 8-9.

[37] 6 NYCRR § 704.2(b)(5)(ii).

[38] 6 NYCRR § 700.1(a)(25) (emphasis supplied).

[39] Since the stormwater associated with the industrial activities at the Facility is subject to separate NPDES permitting requirements, *see* 40 C.F.R. § 122.26, those (apparently uncontrolled) thermal discharges, as well as other sources of heat of artificial origin, need to be considered in conjunction with the Facility's rejected heat effluent.

pollutant parameter in the effluent *in addition to* the dilution of the discharge in the receiving water.[40] Section 6.3.2 of the EPA NPDES Permit Writer's Manual illustrates the type of mass balance water quality equation that should be conducted for a steady-state direct discharge such as the one from the Facility for which monitoring data is available. The record in this case contains no such reasonable potential analysis and Entergy's tri-axial thermal study certainly cannot constitute such an analysis.

The Facility's thermal discharge violates a wide array of water quality standards above and beyond the numeric temperature criteria, and causes, has the potential to cause, or contributes to the following violations of water quality standards, as is explained further herein and as supported by Riverkeeper's accompanying technical comments:

► Heated effluent (which is a discharge of industrial waste)[41] impairs the best usages of the receiving water.[42]

► The protection and propagation of a balanced, indigenous population of fish, shellfish and wildlife in and on the receiving water is not assured.[43]

► Large day-to-day fluctuations in temperature occur in the receiving water.[44]

► The water temperature at the surface of the receiving water is raised to more than 90 degrees Fahrenheit.[45]

► The temperature of more than 50% of the cross-sectional area and volume and/or flow of the estuary is raised more than four degrees Fahrenheit and/or over 83 degrees Fahrenheit over the temperature that existed before the addition heat of artificial origin.[46]

---

[40] *American Iron & Steel Inst. v. EPA*, 115 F.3d 979, 999 (D.C. Cir. 1997), quoting 40 C.F.R. § 122.44(d)(1)(ii).

[41] ECL § 17-0105(5); 6 NYCRR § 700.1(a)(26), 6 NYCRR § 701. 1, 6 NYCRR § 701.11 and6 NYCRR § 864.6 In the alternative and at a minimum, heated effluent could be defined as an "other waste" within the meaning of 6 NYCRR § 701.1.

[42] 6 NYCRR § 701.1.

[43] 6 NYCRR § 704.1(a).

[44] 6 NYCRR § 704.2(a)(3).

[45] 6 NYCRR § 704.2(b)(5)(i). *See, .e.g.,* Entergy's May 3, 2011 Alternative Mixing Zone Explanation, Figure 1; Entergy's March 29, 2011 Response to NYSDEC Staff Review 11.

[46] 6 NYCRR § 704.2(b)(5)(ii). As is set forth more fully in Riverkeeper's accompanying technical comments, Entergy's tri-axial thermal study does not properly consider the effect of heat of artificial origin as that term is defined by 6 NYCRR § 701.1(a)(25): "Following the procedure described in the earlier modeling report (Swanson et al., 2010b), i.e., running the model *without any thermal discharges*, the results showed that the surface ambient temperature during this period was always under 83°F, which is the ambient threshold at which the allowable plume temperature rise is limited to 1.5°F versus 4°F." *Indian Point Final Report 2010 Field Program & Modeling Analysis of the Cooling Water Discharge* at ii. Moreover, the flawed conclusions of Entergy's tri-axial thermal study pertain to causation of water quality violations (that is, whether the discharge, standing alone, complies with

▶ From July through September, when water temperature at the surface of the estuary before the addition of heat of artificial origin is more than 83 degrees Fahrenheit, the temperature of the estuarine passageway as delineated above is raised more than 1.5 Fahrenheit degrees.[47]

▶ Existing instream water uses and the level of water quality necessary to protect the existing uses are neither maintained nor protected.[48]

Whether considered in the context of causation of, reasonable potential for causation of, or contribution to violations of water quality standards, the operation of the Facility in once-through cooling mode subverts the command of the Clean Water Act that discharges be controlled beyond the minimum requirements of TBELs. Accordingly, NYSDEC should require a WQBEL in the form of closed cycle cooling for the Facility's thermal discharge.

Issue No. 4: *The SPDES Permit as Modified Violates the Clean Water Act's Antidegradation Policy*

The proposed Thermal Modification would violate the fundamental protections provided and required by the CWA's antidegradation policy. At a minimum, EPA notes, a state must apply antidegradation requirements to activities which result in significant degradation of water quality, are regulated under state or federal law and require a permit.[49] EPA's CWA implementing regulations require that water quality standards include an antidegradation policy.[50] Antidegradation requires that "existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected."[51]

As is set forth more fully in Riverkeeper's accompanying technical comments, the Facility's thermal discharge clearly damages and impairs the existing fishery and aquatic habitat uses of

---

water quality standards) and do not consider reasonable potential for or contribution to water quality violations, rather, the tri-axial thermal study simply determined that "IPEC was in compliance with NYSDEC Thermal WQS."*Id.* at 119.

[47] 6 NYCRR § 704.2(b)(5)(iii). *See supra* note 36.

[48] Existing uses are those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards. 40 C.F.R. § 131.2(e). The Clean Water Act's antidegradation policy requires that existing uses be maintained and protected. *See* Riverkeeper Issue No. 4, *infra, see also PUD No. 1 v. Wash. Dep't of Ecology,* 511 U.S. 700, 705 (1994), quoting 40 C.F.R. § 131.12

[49] *Ohio Valley Environmental Coalition v. Horinko*, 279 F.Supp.2d 732, 769 (S.D.W.Va. 2003), citing 63 Fed. Reg. 36742, 36783 (July 7, 1998).

[50] 40 C.F.R. § 131.6(d).

[51] *PUD No. 1 v. Wash. Dep't of Ecology,* 511 U.S. 700, 705 (1994), quoting 40 C.F.R. § 131.12

the Hudson River estuary. Moreover, since the Facility does not meet a number of applicable water quality criteria the uses of the Hudson River are not being protected.[52]

As is set forth more fully in Riverkeeper's accompanying technical comments, NYSDEC has recognized the historical impacts of the Facility's thermal discharge on the overall fishery and habitat which existed in the Hudson River.[53] Species such as tomcod and rainbow smelt have been impacted by the Facility's thermal discharge and their populations have declined dramatically since November 28, 1975.[54] The 2003 FEIS notes that previously-abundant tomcod populations in the Hudson River have been monitored since 1974 and are now virtually absent from the River.[55] As the FEIS explains:

> Atlantic tomcod spawning begins in mid-February and extends into mid-March in the Hudson River. The area of peak spawning is in the Highlands section of the river near Con Hook approximately 5 river miles upriver from Indian Point. When eggs and yolk sac larvae drift down river, in addition to being exposed to entrainment, they are also exposed to a thermal plume from Indian Point Units 2 and 3 which extends the entire width of the river on flood tide and across more than two thirds of the width on ebb. In years of high freshwater floods, larvae are transported down river by current into the Haverstraw region or the Tappan Zee region while maturing. Post yolk sack tomcod then concentrate near the leading edge of the salt front (approximately 1 ppt salinity) and move with the tidal flow. In dry years with low freshwater input, this front can be located in the Indian Point region. This results in tomcod larvae congregating in the leading edge of the salt front, being repeatedly moved past the Indian Point station discharge and intakes, potentially increasing the thermal and entrainment effects of the plant on this species. Less than average rainfall from 1995 into 2002 reduced the freshwater flow in the Hudson River. This

---

[52] When water quality criteria are met, water quality will *generally* protect the designated use. *See* 40 C.F.R. § 131.3(b). Designated uses must be at least as protective of water quality as existing uses. 40 C.F.R. § 130.10. Since the Facility's thermal discharge violates applicable criteria and impairs designated uses, existing uses are not being protected with once-through cooling and any SPDES permit that allows for once-through cooling would violate antidegradation.

[53] *See* Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 & 2, Bowline 1 & 2, and Indian Point 2 & 3 Steam Electric Generating Stations, Accepted by the New York Department of Environmental Conservation on June 25, 2003 (hereinafter "2003 FEIS"); see also Final Environmental Statement Related to Operation of Indian Point Nuclear Generating Plant Unit No. 2, Consolidated Edison Company of New York, Inc., September 1972 – Docket No. 50-247 [AEC, Directorate of Licensing]; and Final Environmental Statement Related to Operation of Indian Point Nuclear Generating Plant Unit No. 3, Consolidated Edison Company of New York, Inc., February 1975 – Docket No. 50-286 [NUREG-75/002].

[54] This is the operative date for establishing existing uses as per 40 C.F.R. § 131.2(e).

[55] *See* 2003 FEIS at 66-67.

> period corresponds to the period of rapid decline in numbers of Atlantic tomcod in the Hudson River.[56]

The Thermal Modification proposes to allow the Facility to maintain these indisputably detrimental thermal discharges to the Hudson River. But no activity that would "'partially or completely eliminate any existing use" can be permitted, "even if it would leave the majority of a given body of water undisturbed." [57] Rainbow smelt populations have been similarly impacted:

> Because the Hudson River is located in the southern portion of the rainbow smelt's east coast range, one might reasonably conclude that observed increases in ocean and coastal water temperatures, as from global climate change, have caused a range shift northward, with the smelt abandoning its southernmost range. However, smelt populations at nearly the same latitudes as the Hudson River Estuary remain stable. This fact may indicate that localized influences have caused the apparent local disappearance of this species in the Hudson River. Thermal discharges, as from power plants, may be a principal factor in the disappearance of this species from the Hudson estuary.[58]

Riverkeeper's accompanying technical comments further illustrate the impact of the Facility's thermal discharge on the once-abundant and existing fisheries of the Hudson River.

Even if the Facility's thermal discharge were not impairing existing uses in contravention of the most fundamental protections of antidegradation (which it clearly is doing), NYSDEC has failed to conduct a legally sufficient antidegradation analysis for the proposed Thermal Modification. EPA's antidegradation regulation further provides (again, at a minimum) that

> Where the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the State shall assure water quality adequate to protect existing uses fully. Further, the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and

[56] 2003 FEIS at 67-68 (internal footnotes omitted).

[57] *Islander E. Pipeline Co., LLC v. McCarthy*, 525 F.3d 141, 144 (2d Cir. 2008), quoting *PUD No. 1 v. Washington Dep't of Ecology*, 511 U.S. at 718-19 (quoting EPA, Questions and Answers on Antidegradation at 3 (Aug. 1985).

[58] 2003 FEIS at 65.

> existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.[59]

The proposed Thermal Modification is not supported by the requisite socio-economic justification required by 40 C.F.R. § 131.12(a)(2). As previously noted, the proposed Thermal Modification does not assure adequate water quality to fully protect existing uses. The proposed Thermal Modification does not mandate the "highest statutory and regulatory requirements" for existing point source discharges, particularly the thermal discharge at issue (for which NYSDEC has required neither a TBEL nor a WQBEL).

Nor does the proposed Thermal Modification assure that all cost-effective and reasonable best management practices (BMPs) are required for nonpoint source control. To the contrary, cumulative effects of all sources of "heat of artificial origin,"[60] including the heated stormwater runoff from the Facility, were not considered and do not appear to be regulated in any fashion. It is in fact undisputed that "the discharge of radiological substances (including, but not limited to, radioactive liquids, radioactive solids, radioactive gases, and stormwater)"[61] has occurred and continues to occur at the Facility from a variety of diffuse sources. Although the draft SPDES permit includes BMPs for toxic or hazardous pollutants,[62] it does not appear to require BMPs to address stormwater or the thermal and radiological components contained in such stormwater.[63]

EPA's antidegradation regulation further requires the state to implement antidegradation in a manner that is at least as protective as Section 316 of the CWA:

> In those cases where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with section 316 of the Act.[64]

Section 316 of the CWA, in turn, requires the imposition of the best technology available to minimize adverse environmental impacts from cooling water intakes, and also requires that thermal discharges assure the protection and propagation of a balanced, indigenous population (BIP) of shellfish, fish and wildlife in the receiving waters. While the proposed Thermal

[59] 40 C.F.R. § 131.12(a)(2).

[60] 6 NYCRR § 700.1(a)(25).

[61] NYSDEC April 2, 2010 Denial of Water Quality Certification at 11.

[62] 2004 Draft SPDES permit at 20-24.

[63] Riverkeeper recognizes that the discharge of radiological substances cannot be authorized by a SPDES permit and is unlawful *per se*. ECL § 17-0807(1). Accordingly, Entergy cannot show, and NYSDEC cannot find, that cost effective and reasonable BMPs are required for radiological discharges in any event and thus the SPDES permit cannot satisfy antidegradation as a result.

[64] 40 C.F.R. § 131.12(a)(4).

Modification recites similar language from NYSDEC's thermal criteria regulations,[65] nothing in the proposed permit term provides any restrictions to require that the criteria are met, or indicates how NYSDEC will determine compliance.

The permit term reduces itself to a mere tautology by reciting the thermal criteria standards while providing nothing in the way of restrictions on the discharge, measures for enforcement purposes, or indeed any showing as to what the BIP is and how its protection and propagation shall be assured.

Issue No. 5: *The Draft SPDES Permit with the Thermal Modification Violates the Clean Water Act and other Applicable Law Because it is Unsupported by a BIP Demonstration*

Since New York's water quality standards require that all thermal discharges shall assure the protection and propagation of the BIP,[66] any applicant for a SPDES permit for a thermal discharge must demonstrate compliance with that standard. As noted, the NYSDEC thermal criteria make reference to the requirement for the protection and propagation of the BIP, but those regulations do not define the term BIP. Since the state standards must be at least meet the federal minimums of the Clean Water Act,[67] reference to EPA's definition of the term BIP is appropriate. EPA defines a BIP as follows:

> The term balanced, indigenous community is synonymous with the term balanced, indigenous population in the Act and means a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination by pollution tolerant species. Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence or abundance is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 301(b)(2) of the Act; and may not include species whose presence or abundance is attributable to alternative effluent limitations imposed pursuant to section 316(a).[68]

The discharger bears a stringent burden of proof to demonstrate that its discharge will ensure

---

[65] 6 NYCRR § 704.1(a) provides: "All thermal discharges to the waters of the State shall assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water."

[66] 6 NYCRR § 704.1(a).

[67] CWA § 510, 33 U.S.C. § 1370; 40 C.F.R. § 131.4(a).

[68] 40 C.F.R. § 125.71(c).

protection and propagation of the BIP.[69] In order to meet the standard of demonstrating that the proposed discharge will assure the protection and propagation of the BIP an existing discharger may: (1) employ a retrospective demonstration showing that no prior appreciable harm has resulted from the discharge, or (2) employ a prospective demonstration showing that, despite such previous harm, the discharge will nevertheless ensure the protection and propagation of the BIP.[70] In determining whether or not prior appreciable harm has occurred, the permitting authority must consider "the length of time in which the applicant has been discharging and the nature of the discharge."[71]

To Riverkeeper's knowledge, Entergy has provided NYSDEC with neither an analysis of what constitutes the BIP for the receiving water nor a demonstration that the protection and propagation of the BIP will be assured. Accordingly, there is no basis for NYSDEC to determine either what the BIP is or if the protection and propagation of the BIP will be assured.

To the contrary, the existing and well-documented SPDES record establishes that the Facility's thermal discharges have caused long-standing adverse environmental impacts to aquatic organisms and fish such as stress, injury, shock and mortality.[72] Although the burden is squarely placed and will squarely remain on Entergy to show that the Facility meets the requirements of the Clean Water Act and the ECL,[73] the record of this proceeding thoroughly demonstrates that the Facility has caused prior appreciable harm to the BIP in the light of the nature and long-standing duration of the thermal discharge.[74] Moreover, as previously noted, NYSDEC has recognized the inextricable link between the thermal discharge and the impacts of the Facility's cooling water intake. A determination that the protection and propagation of the BIP will be

---

[69] *In re: Dominion Energy Brayton Point, L.L.C. (Formerly USGen New England, Inc.) Brayton Point Station*, 12 EAD 490(NPDES 03-12), *Remand Order*, (Feb. 1, 2006) 2006 EPA App. LEXIS 9, 163-164 (expressly rejecting the discharger's arguments apparent arguments that the burden was on EPA to show that the thermal discharge at issue would not ensure the protection and propagation of the BIP).

[70] *Id.*, quoting 40 C.F.R. § 125.73.

[71] *Id.*, quoting 40 C.F.R. § 125.73(c)(2).

[72] *See* Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 & 2, Bowline 1 & 2, and Indian Point 2 & 3 Steam Electric Generating Stations, Accepted by the New York Department of Environmental Conservation on June 25, 2003; see also Final Environmental Statement Related to Operation of Indian Point Nuclear Generating Plant Unit No. 2, Consolidated Edison Company of New York, Inc., September 1972 – Docket No. 50-247 [AEC, Directorate of Licensing]; and Final Environmental Statement Related to Operation of Indian Point Nuclear Generating Plant Unit No. 3, Consolidated Edison Company of New York, Inc., February 1975 – Docket No. 50-286 [NUREG-75/002].

[73] CWA § 316(a), 33 U.S.C. § 1326(a); 6 NYCRR § 624.9(b)(1).

[74] 40 C.F.R. § 125.73(c)(2); *see also* August 13, 2008 Interim Decision of the Assistant Commissioner, *Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC*, DEC No. 3-5522-00011/0004, SPDES No. NY-0004472 at 15 (finding that the requisite adverse environmental impact specified in 6 NYCRR § 704.5 has been thoroughly demonstrated in the record of this proceeding and that therefore no reason exsited to adjudicate that issue).

assured requires a consideration of the cumulative impact of the thermal discharge together with all other significant impacts.[75]

While Riverkeeper disputes that NYSDEC can issue a SPDES permit for the discharge at issue without granting a variance,[76] the standard for *all* thermal discharges in New York requires an assurance of the protection and propagation of the BIP. Section 316(a) of the Clean Water Act and its implementing regulations at 40 C.F.R. Part 125 clearly delineate what is required to make a showing that the protection and propagation of the BIP shall be assured. While there is a difference between the respective agency actions (i.e., granting a variance or establishing a mixing zone), the regulatory requirement and ecological analysis (that is, the assurance of the protection and propagation of the BIP) remain the same. That analysis is lacking with respect to the proposed Thermal Modification.

Issue No. 6: *The Proposed Mixing Zone Is Illegal*

i) The Mixing Zone Violates the Clean Water Act

Permissible mixing zone characteristics should be established to ensure that

(1) mixing zones do not impair the integrity of the water body as a whole;
(2) there is no lethality to organisms passing through the mixing zone; and
(3) there are no significant health risks, considering likely pathways of exposure.[77]

While the decision as to whether to create mixing zones is a matter of state discretion, any decision to allow mixing zones must be consistent with the CWA's antidegradation policy.[78] Mixing zones are permissible so long as a number of fundamental protections, such as the absence of lethal conditions to aquatic life, are maintained.[79] By definition, a mixing zone is a defined area.[80] "The size and configuration of the mixing zone is a crucial variable in

[75] 40 C.F.R. § 125.73(a).

[76] *See* Riverkeeper's Issue No. 8, *infra.*

[77] *American Wildlands v. Browner,* 94 F. Supp. 2d 1150, 1162 (D. Colo. 2000), citing EPA WATER QUALITY STANDARDS HANDBOOK . SPDES permits must ensure that discharges will conform to and meet the requirements of the Clean Water Act (CWA) and as well as all rules, regulations and guidelines adopted pursuant thereto. ECL § 17-0801.

[78] *Id.* at 1162, citing 33 U.S.C. § 1313(d)(4)(B).

[79] *Am. Wildlands v. Browner,* 260 F.3d 1192, 1195 (10th Cir. 2001), quoting EPA WATER QUALITY STANDARDS HANDBOOK § 5.1.1, at 5-5 (2d ed.1994).

[80] *Puerto Rico Sun Oil Co. v. United States EPA,* 8 F.3d 73, 75 (1st Cir. 1993).

determining whether or not a given effluent can be discharged."[81] But the Thermal Modification permits a 75-acre undefined mixing zone[82] which includes temperatures which are lethal to aquatic biota and in violation of the antidegradation policy. Accordingly, the proposed Thermal Modification violates the Clean Water Act.

ii) <u>The Mixing Zone Violates New York's Water Quality Standards for Mixing Zones</u>

The proposed Thermal Modification fails to specify definable, numerical limits for the thermal discharge's mixing zone.[83] The Thermal Modification simply permits a blanket mixing zone of seventy five (75) acres (roughly three million square feet), without any reference to linear distances from the point of discharge or the location of the discharge—which will of course change directions several times a day as the tide changes in this estuarine receiving water. Moreover, as is explained in Riverkeeper's accompanying technical comments, the actual area impacted by the thermal plume is greater than 75 acres. In any event, the Hudson River is only .7 nautical miles across at Indian Point, so a 75-acre mixing zone could completely block the Hudson River.[84] Since the area of the thermal plume is in fact larger than the allocated 75-acre mixing zone, the mixing zone's surface area involvement has been understated and the thermal plume's ability to cover the entire receiving water from shore to shore has not been considered.

Moreover, NYSDEC's mixing zone regulations prohibit the location of mixing zones for thermal discharges where the mixing zone will simply "interfere" with (rather than block) spawning areas, nursery areas and fish migration routes.[85] The Hudson River estuary in the vicinity of Indian Point serves all such purposes. Conditions in the mixing zone cannot be lethal in contravention of water quality standards to aquatic biota which may enter the zone.[86] As is set forth more fully in Riverkeeper's accompanying technical comments, Entergy's tri-axial thermal study shows that surface water temperatures in excess of 90 degrees Fahrenheit or greater (lethal temperature for many aquatic organisms) covering up to fourteen (14) acres within the "inferred mixing zone." Thus, the mixing zone creates massive areas where conditions are lethal to aquatic biota, many of which drift with the current and cannot avoid the thermal plume. As is also set forth in Riverkeeper's accompanying technical comments, inferred mixing zone interferes with spawning and nursery areas in the littoral zone.

---

[81] *Marathon Oil Co. v. EPA,* 830 F.2d 1346, 1349 (5th Cir. 1987).

[82] As is set forth more fully in Riverkeeper's accompanying technical comments, the area of the thermal plume which exceeds thermal numeric water quality standards is actually greater than 75 acres.

[83] 6 NYCRR § 704.3(a).

[84] Riverkeeper's accompanying technical comments provide additional in-depth discussion of these issues.

[85] 6 NYCRR § 704.3(c).

[86] 6 NYCRR § 704.3(b).

iii) The Mixing Zone is Inconsistent With EPA Guidance

EPA has provided very specific guidance with regards to mixing zones, which NYSDEC has failed to abide by in granting Entergy the Thermal Modification:

> EPA recommends that mixing zone characteristics be defined on a case-by-case basis after it has been determined that the assimilative capacity of the receiving system can safely accommodate the discharge. This assessment should take into consideration the physical, chemical, and biological characteristics of the discharge and the receiving system; the life history and behavior of organisms in the receiving system; and the desired uses of the waters. Mixing zones should not be permitted where they may endanger critical areas (e.g., drinking water supplies, recreational areas, breeding grounds, areas with sensitive biota)"[87]

As noted above, the Thermal Modification did not include a WQBEL analysis or a demonstration of what constitutes the BIP or what will assure the protection and propagation thereof. As Riverkeeper's accompanying technical comments illustrate, Entgery has not demonstrated that the receiving water can safely accommodate the Facility's thermal discharge. Thus, NYSDEC did not consider the physical, chemical and biological characteristics of the receiving water or the life history and behavior of the organisms in the receiving waters when it issued the proposed thermal modification. Nor did NYSDEC consider the critical area into which the unabated thermal discharge would be allowed, that is, a critical estuarine breeding habitat with sensitive biota, including endangered short nosed sturgeon.

As EPA's Water Quality Handbook explains, a disproportionately large mixing zone (like the one at issue) "could potentially adversely impact the productivity of the water body and have unanticipated ecological consequences" and thus mixing zones "should be carefully evaluated and appropriately limited in size."[88] Here, NYSDEC did not carefully evaluate or appropriately limit the size of the mixing zone.

The size of the mixing zone at issue implicates the zone of passage for aquatic biota. Zones of passage are defined by EPA as "continuous water routes of such volume, area, and quality as to allow passage of free-swimming and drifting organisms so that no significant effects are produced on their populations." [89] As EPA further explains:

> Transport of a variety of organisms in river water and by tidal movements in estuaries is biologically important for a number of reasons:

---

[87] EPA, WATER QUALITY HANDBOOK 5.1, *available at* http://water.epa.gov/scitech/swguidance/standards/handbook/chapter05.cfm. (last visited July 12, 2011).

[88] *Id.* at 5.1.1.

[89] *Id.* at 5.1.1.

- food is carried to the sessile filter feeders and other nonmotile organisms;
- spatial distribution of organisms and reinforcement of weakened populations are enhanced; and
- embryos and larvae of some fish species develop while drifting.[90]

The objective of carefully evaluating the sensitivity of the receiving water and appropriately sizing the mixing zone "is to provide time-exposure histories that produce negligible or no measurable effects on populations of critical species in the receiving system."[91] Here, Entergy's own data shows that maximum temperatures in the proposed zone would be allowed to exceed lethal thresholds with observed temperatures of 95 degrees Fahrenheit[92] or higher.[93]

iv) <u>The Methodology Attempting to Support and Indicate the Mixing Zone is Insufficient.</u>

The flaws in the methodology include,[94] but are not limited to the following: (as noted *supra* and *infra)*:

- <u>Failure to properly consider heat of artificial origin</u>: As is set forth more fully in Riverkeeper's accompanying technical comments, Entergy's tri-axial thermal study does not properly consider the effect of heat of artificial origin as that term is defined by 6 NYCRR § 701.1(a)(25): "Following the procedure described in the earlier modeling report (Swanson et al., 2010b), i.e., running the model *without any thermal discharges*, the results showed that the surface ambient temperature during this period was always under 83°F, which is the ambient threshold at which the allowable plume temperature rise is limited to 1.5°F versus 4°F." *Indian Point Final Report 2010 Field Program & Modeling Analysis of the Cooling Water Discharge at ii.* Moreover, the flawed conclusions of Entergy's tri-axial thermal study pertain to causation of water quality violations (that is, whether the discharge, standing alone, complies with water quality standards) and do not consider reasonable potential for or contribution to water quality violations, rather, the tri-axial thermal study simply determined that determine that "IPEC was in compliance with NYSDEC Thermal WQS."*Id.* at 119.

- <u>Failure to properly evaluate MA7CD10 and APAC</u>: Entergy declined to even conduct the analysis under the worst-case scenarios requested by NYSDEC staff, i.e., "under

[90] *Id.* at 5.1.1.

[91] *Id.* at 5.1.2.

[92] March 29, 2011 ASA Part 1 Response to NYSDEC Staff review of 2010 Thermal Field Program and Modeling Analysis at 11.

[93] *See* Riverkeeper's accompanying technical comments.

[94] We note that Riverkeeper has not had discovery with respect to Entergy's thermal submissions in the SPDES and CWA Section 401 proceedings and thus respectfully reserves the right to comment further at a later date.

MA7CD10 (7 day, 10 year low flow) and the lowest flow for the available record period, background temperature in the river of 90 degrees Fahrenheit (at "slack ebb begin" and "slack flood begin" tide conditions), and during thermal stratification periods. . .and at [a]ll predictions are to be performed at All Plants at Capacity (APAC) conditions." NYSDEC April 2, 2010 401 Denial at 12.

- Inaccurate assumptions as to the ambient temperature: See Riverkeeper Technical Comments at 16 – 17.

- Projected Climate Change is not considered: See Riverkeeper Technical Comments at 15; also, please see *infra*, Issue #11.

Issue No. 7: *Since the Mixing Zone is Illegal, the Thermal Discharge Will Continue to Violate New York's Thermal Criteria*

As noted in Riverkeeper's Issue No. 5, there has not been any demonstration that the discharge will "assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water," and such a showing is required in order to show compliance with New York's thermal discharge criteria.[95] Further, as is set forth in the attached technical comments, the discharge will cause large day-today temperature fluctuations due to heat of artificial origin.[96]

Moreover, the thermal discharge violates specific numerical water quality criteria applicable to estuaries.[97] As is set forth more fully in Riverkeeper's accompanying technical comments, the thermal discharge raises the surface water temperature of the estuary over ninety degrees across large sections of the Hudson River,[98] and raises the temperature of more than fifty percent (50%) of the cross sectional area and/or volume of the flow of the Hudson River (including more than one-third of the surface as measured from water edge to water edge at any stage of the tide) more than four degrees Fahrenheit over the temperature that existed before the addition of heat of artificial origin and to a maximum of 83 degrees Fahrenheit,[99] all in violation of New York's estuarine thermal criteria. As NYSDEC's consultant opined in a related NRC proceeding:

> Specifically, operation of the Indian Point facilities alone is predicted to violate 6 N.Y.C.R.R. section 704.2(5)(ii). Where the criteria require that a minimum of one-third of the surface shall not be raised more than four Fahrenheit degrees, model results indicate that 100% of the surface width will be raised by more than four

[95] 6 NYCRR § 704.1(a).

[96] 6 NYCRR § 704.2(a)(3).

[97] 6 NYCRR § 704.2(b)(5).

[98] 6 NYCRR § 704.2(b)(5)(i).

[99] 6 NYCRR § 704.2(b)(5)(ii).

> degrees (i.e., 0% of the surface width will not be raised) during certain tidal conditions.[100]

NYSDEC has recognized that the Facility's thermal discharges (alone and when considered along with all thermal discharges in the region) violate New York's thermal water quality standards.[101]

Since the unabated thermal discharge is emitted at lethal temperatures and in vast quantities into a sensitive estuarine system and otherwise fails to satisfy numerous state and federal requirements for mixing zones, the discharge cannot be allowed via a mixing zone and thus violates water quality standards.

Issue No. 8: *Since the Thermal Discharge Will Continue to Violate Water Quality Standards, if Closed-Cycle Cooling is Not Required, Entergy Must Seek a Variance Under Section 316(a) of the Clean Water Act and 6 NYCRR § 704.4.*

The proposed Thermal Modification has been issued in violation of Sections 301 and 303 of the Clean Water Act, including, without limitation, effluent limitation requirements, antidegradation requirements and New York's water quality standards relating to thermal criteria and mixing zones. Accordingly, there are several reasons which require NYSDEC to mandate the installation of closed-cycle cooling for the Facility's thermal discharge as it has done for the Facility's cooling water intake. The Facility stands apart from other steam electric generating plants as uniquely injurious to the aquatic environment. As NYSDEC's consultant has put it:

> IP2 and IP3 draw enormous amounts of water -- 2.5 billion gallons each day. Nearly all of this water is eventually discharged into the Hudson River, but at a much higher temperature because it has been used to cool the plants' operations. Collectively, the maximum permitted thermal discharge for IP2 and IP3 is for trillions of BTUs of total heat per year. Based on my review of the EPA Permit Compliance System, *these BTU limits are hundreds of times larger than most power facilities.*[102]

As with the entrainment impacts associated with the Facility's cooling water intake (over a billion aquatic organism per year), the numbers associated with this particular facility are simply so staggering (roughly 2.5 billion gallons of water per day discharged as waste heat totaling

---

[100] *In re License Renewal Application Submitted by Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, & Entergy Nuclear Operations, Inc.*, New York State Notice of Intention to Participate and Peitition to Intervene, 2007 NRC LEXIS 167, 599-627 (NRC 2007), Declaration of David W. Dilks, ¶19.

[101] *Id.* at ¶ 18.

[102] *Id.* at ¶ 7.

trillions of BTUs per year) that the Facility stands apart. The Facility is the largest user of water in the state[103] and it discharges heated effluent in amounts nearly equal to its intake.

Accordingly, even if NYSDEC declines to require closed-cycle cooling as a TBEL or WQBEL for the thermal discharge, the discharge is not an appropriate candidate for a mixing zone approach to compliance. Even if NYSDEC were to ignore the mandates of Sections 301 and 303 of the Clean Water Act, NYSDEC could not allow Entergy to circumvent the requirements of Section 316(a) of the Act by exceeding thermal criteria and operating in circumvention of effluent limitations without seeking a variance.[104] Notably, both federal and state law require the opportunity for a public hearing on a variance.[105]

Issue No. 9: *The Draft SPDES Permit with the Thermal Modification Allows for the Impairment of Best Usages*

New York regulations require that discharges "shall not cause impairment of the best usages of the receiving water as specified by the water classifications at the location of discharge and at other locations that may be affected by such discharge."[106] New York designated the Hudson River in the vicinity of the Facility as a Class SB saline surface water,[107] and thus its best uses are "primary and secondary contact recreation and fishing"[108] and the waters must be "be suitable for fish, shellfish, and wildlife propagation and survival."[109] As previously noted, the Thermal Modification was issued without consideration of TBELs, WQBELs, antidegradation or an analysis and presentation of the composition of the BIP and consideration of whether the protection and propagation of the BIP will be assured. Moreover, the use a 75-acre mixing zone (which is actually smaller than the thermal plume) with lethal temperatures is in direct contravention of thermal water quality criteria, mixing zone requirements and the requirements to protect and support existing and designated uses.

Entergy's tri-axial thermal study addresses the Facility's compliance with numerical thermal criteria but lacks any predictive assessment of biological effects on designated uses. Riverkeeper disputes Entergy's conclusions with respect to numerical thermal criteria as set forth herein and in Riverkeeper's accompanying technical comments. But it is well-settled that compliance with water quality standards involves more than meeting numeric criteria. As previously noted herein, the record is devoid of any antidegradation analysis with respect to

---

[103] 2003 NYSDEC FEIS at 71, n. 175.

[104] CWA § 316(a), 33 U.S.C. § 1326(a), 6 NYCRR § 704.4.

[105] CWA § 316(a), CWA § 1326(a), 6 NYCRR § 704.4(e).

[106] 6 N.Y.C.R.R. § 701.1.

[107] 6 N.Y.C.R.R. § 868.6.

[108] 6 N.Y.C.R.R. § 701.11.

[109] 6 N.Y.C.R.R. § 701.11.

existing uses. "Under the literal terms of [the CWA], a project that does not comply with a designated use of the water does not comply with the applicable water quality standards."[110] Use designations "must be translated into specific limitations for individual projects."[111] Entergy's tri-axial thermal study focuses on numeric criteria rather than the effect of the discharge on designated and existing uses. Entergy's failure to separately address compliance with designated uses and existing uses (and the absence of any independent analysis of those questions by NYSDEC) is compounded by the record of this proceeding which thoroughly demonstrates the impact of the Facility's long-standing and uncontrolled thermal discharge.[112]

The thermal discharge of Indian Point also impairs the best usage of the waters of the Hudson River for propagation and survival of endangered and threatened species.[113] In particular, it is undisputed that endangered shortnose sturgeon and threatened Candidate Species Atlantic sturgeon reside in the Hudson River in the vicinity of Indian Point, and that these species are impacted by the thermal effluent emanating from the plant.[114]

Issue No. 10: *NYSDEC Must Impose a Schedule of Compliance as an Interim Measure With Respect to the Facility's Thermal Discharge*

Since the discharge is not in compliance with applicable effluent limitations, water quality standards or the requirements of antidegradation, NYSDEC must "establish specific steps in a compliance schedule designed to attain compliance within the shortest reasonable time" consistent with the Clean Water Act and Article 17 of the ECL.[115] The schedule of compliance must comply with time requirements for interim actions[116] and the substantive requirements of 6

[110] *PUD No. 1 v. Wash. Dep't of Ecology,* 511 U.S. 700, 705 (1994), quoting 40 C.F.R. § 131.12.

[111] *Islander E. Pipeline Co., LLC v. McCarthy,* 525 F.3d 141, 165 (2d Cir. 2008).

[112] 40 C.F.R. § 125.73(c)(2); *see also* August 13, 2008 Interim Decision of the Assistant Commissioner, *Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC,* DEC No. 3-5522-00011/0004, SPDES No. NY-0004472 at 15 (finding that the requisite adverse environmental impact specified in 6 NYCRR § 704.5 has been thoroughly demonstrated in the record of this proceeding and that therefore no reason exsited to adjudicate that issue).

[113] *See* 6 N.Y.C.R.R. § 701.11.

[114] *See* Letter from Mary A. Colligan (Assistant Regional Administrator for Protected Resources, National Marine Fisheries Service (NFMS)) to James A. Thomas (Enercon Services, Inc.), January 23, 2007 ("A population of federally endangered shortnose sturgeon (*Acipenser brevirostrum*) occurs in the Hudson River. Shortnose sturgeon have been documented to occur in the Hudson River from the northern end of Staten Island in New York Harbor (RM -3) to the Troy Dam (RM 151). . . . [A]dult shortnose sturgeon concentrate . . . near Haverstraw Bay (RM 33-40). . . . most juveniles occupy the broad region of Haverstraw Bay (RM 33-40) by late fall and early winter. . . . Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are also present in the Hudson River. . . . Sturgeon yolk sac larvae (YSL) and post yolk sac larvae (PYSL) have been documented in the vicinity of Indian Point. . . . NMFS has several concerns regarding the potential for the authorized withdrawals and discharges to affect sturgeon. . . . Both shortnose and Atlantic sturgeon may also be affected by the discharge of heated effluent, chlorine, and other pollutants or antifouling agents.").

[115] 6 NYCRR § 750-1.14(a); ECL § 17-0813.

[116] 6 NYCRR § 750-1.14(b).

NYCRR § 750.1-14 including, without limitation, a pollutant minimization program for the thermal discharges which are impairing or precluding the best usages of the receiving water.[117]

The draft SPDES permit includes a schedule of compliance to reduce entrainment via scheduled outages of no fewer than 42 unit-days between February 23 and August 23 of each calendar year.[118] This provision should be revised to require additional scheduled outages which must occur during the warmest months of the year (July and August) in order to abate the Facility's thermal discharge.

Issue No. 11: *The Thermal Modification Fails to Take Climate Change into Account*

NYSDEC policy requires that all Departmental activities, including permitting, are to integrate climate change considerations.[119] It is also Federal policy to assess and account for climate change in developing permit limits and standards for protecting waterways.[120] All NYSDEC Divisions, Offices and Regions are required to integrate the climate change policy into their programs as follows:[121]

> Department staff are directed to integrate climate change considerations as may be relevant, along with other environmental issues and State priorities, into the full range of their Departmental activities, including but not limited to all decision-making, planning, permitting, remediation, rulemaking, grant administration, natural resource management, enforcement, land stewardship, facilities management, internal operations, contracting, procurement, and public outreach and education.[122]

The policy goes on further to require that analyses and decision-making processes use the best available scientific information of environmental conditions resulting from the impacts of climate change such as increased air and water temperatures and incorporate measures "that

---

[117] 6 NYCRR § 750-1.14(f).

[118] 2004 Draft NPDES permit at 16.

[119] NYSDEC Policy CP-49 dated October 22, 2010 at 2.

[120] *See* Chesapeake Bay Protections and Restoration Executive Order §§ 202, 601 (May 12, 2009) at 6 (requiring federal agencies to "assess the impacts of a changing climate on the Chesapeake Bay and develop a strategy for adapting natural resource programs and public infrastructure to the impacts of a changing climate on water quality and living resources of the Chesapeake Bay watershed" and to include the assessment of temperature and effects on fish habitat). EPA accordingly accounted for climate change in its issuance of the Nutrient TMDL for the Chesapeake Bay. Final Chesapeake Bay TMDL (December 29, 2010). 76 Fed. Reg. 54901 (Jan. 5, 2011). The Chesapeake Bay TMDL can be found at http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/tmdlexec.html (last visited July 14, 2011).

[121] NYSDEC Policy CP-49 at 6.

[122] NYSDEC Policy CP-49 at 2.

enhance the capacity of ecosystems and communities to absorb and/or accommodate the impacts of climate change."[123] Such objectives are particularly relevant to NYSDEC's decision regarding the Facility's proposed mixing zone.

III: Conclusion

Based on the foregoing as supported by and in addition to Riverkeeper's accompanying technical comments, Riverkeeper respectfully requests that NYSDEC reconsider its issuance of the proposed Thermal Modification, impose the stricter of technology-or-water quality based effluent limitations following a determination of what constitutes the BIP and the performance of legally and technically supportable analyses of the impact of the discharge on the BIP and the receiving water.

Such analyses must include an evaluation of the impacts of the discharge in conjunction with all other sources of heat of artificial origin, and address the Facility's reasonable potential to cause a violation of water quality standards as well as whether the Facility contributes to such a violation. Such analyses must address the protection of existing uses afforded by the antidegradation policy, a socio-economic justification for lowering water quality, and assure that the highest statutory and regulatory requirements for the existing discharge is required, along with cost-effective and reasonable best management practices for nonpoint source controls.

Riverkeeper further submits that when NYSDEC conducts such analyses, NYSDEC will inevitably conclude that a water quality based effluent limitation is required for the Facility's thermal discharge (without regard to questions of cost or technological feasibility) and that a schedule of compliance must be imposed in the interim while Entergy retrofits the Facility to accommodate closed-cycle cooling. If a mixing zone is still required for the Facility after the fundamental dictates of the Clean Water Act have been satisfied, the mixing zone must comply with both state and federal law.

Riverkeeper appreciates NYSDEC's consideration of the above comments. Should you require any clarification, or additional information, please do not hesitate to contact the undersigned at (914) 478-4501.

Very truly yours,

Mark L. Lucas
Hudson River Program Staff Attorney

[123] *Id.* at 3.

Docket ID NRC-2008-0672

Attachment C

to

Riverkeeper, Inc.'s Comments on the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50–247 and 50–286 (June 2012)

RIVERKEEPER.
NY's clean water advocate

July 26, 2012

VIA E-MAIL and U.S. MAIL

Allison M. Macfarlane
Chairwoman
U.S. Nuclear Regulatory Commission
Mail Stop O-16G4
Washington, DC 20555-0001
Chairman@nrc.gov

Kristine L. Svinicki
Commissioner
U.S. Nuclear Regulatory Commission
Mail Stop O-16G4
Washington, D.C. 20555-0001
CMRSVINICKI@nrc.gov

George Apostolakis
Commissioner
U.S. Nuclear Regulatory Commission
Mail Stop O-16G4
Washington, D.C. 20555-0001
CMRAPOSTOLAKIS@nrc.gov

William D. Magwood
Commissioner
U.S. Nuclear Regulatory Commission
Mail Stop O-16G4
Washington, D.C. 20555-0001
CMRMAGWOOD@nrc.gov

William C. Ostendorff
Commissioner
U.S. Nuclear Regulatory Commission
Mail Stop O-16G4
Washington, D.C. 20555-0001
CMROSTENDORFF@nrc.gov

Annette L. Vietti-Cook
Secretary of the Commission
U.S. Nuclear Regulatory Commission
Mail Stop O-16G4
Washington, DC 20555-0001
NRCExecSec@nrc.gov

Re: Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-247-LR, 50-286-LR

Dear Honorable Commissioners of the NRC:

The purpose of this correspondence is to echo and support the letter submitted to the Commission by the State of New York ("State") yesterday, July 25, 2012, relating to respective obligations of both the U.S. Nuclear Regulatory Commission ("NRC") and Entergy Nuclear Operations, Inc. ("Entergy") to comply with Clean Water Act ("CWA") § 401 in the above-referenced proceeding. In light of a ruling by the United States Court of Appeals for the District of Columbia Circuit (*Vermont Dep't of Public Service, et al. v. United States et al.*, No. 11-1168) concerning the issuance of an NRC renewed operating license for a nuclear power facility in

Vermont despite the absence of a CWA § 401 water quality certification ("WQC"), though clearly not pertinent to the Indian Point license renewal proceeding, the State's letter clarifies the record with respect to applicable requirements and relevant and distinguishable circumstances in the instant case.

Riverkeeper Inc. ("Riverkeeper") is a party-intervenor in the Indian Point license renewal proceeding currently pending before an Atomic Safety and Licensing Board ("ASLB"), as well as in New York State proceedings currently pending before a tribunal of the New York State Department of Environmental Conservation ("NYSDEC") concerning (1) Entergy's State Pollutant Discharge Elimination System ("SPDES") permit renewal application and (2) Entergy's discretionary appeal of NYSDEC's April 2010 denial of Entergy's request for a CWA § 401 WQC, which Entergy applied for in connection with the proposed license renewal of Indian Point. Riverkeeper has a paramount interest in the outcome of these proceedings and, accordingly, in the correct interpretation and understanding of the relevant legal framework and regulatory requirements stemming from CWA § 401.

Riverkeeper fully supports and agrees with the State's July 25, 2012 letter concerning these issues, and offers the following additional relevant information.

Entergy Must Obtain a New § 401 WQC to Support the License Renewal of Indian Point

First, Riverkeeper completely agrees with the State, and controlling law clearly dictates, that CWA § 401 requires Entergy to obtain a new WQC before NRC may issue a renewed operating license for Indian Point. The plain language of CWA § 401 states that

> [a]ny applicant for a Federal license or permit to conduct any activity . . . which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates . . . that any such discharge will comply with [applicable State water quality standards]."[1]

This requirement indisputably applies to license *renewal* applications,[2] and in particular, to applications to renew a nuclear power plant operating license.[3]

In relation to Indian Point, a SPDES permit, issued pursuant to CWA § 402, is not sufficient to demonstrate compliance with the WQC requirements of § 401. Riverkeeper agrees with the State that CWA § 401 involves a *separate*, broader, inquiry than the one implicated by CWA § 402. In particular, CWA § 401 requires an *independent* assessment of whether the proposed activity *as a whole* (not simply the discharge that is the subject of a § 402 SPDES permit), will comply with relevant State water quality standards, *and*, by virtue of CWA § 401(d), any *other* appropriate State standards beyond those specifically enumerated in the CWA; thus, the State's §

[1] Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. § 1341.

[2] *S.D. Warren Co. v. Maine Board of Envtl. Prot.*, 547 U.S. 370, 380, 126 S.Ct. 1843 (2006).

[3] *See* 10 C.F.R. §§ 2.4, 50.54(aa), 54.33(c).

401 inquiry involves as assessment of whether the proposed activity complies with numerical criteria, designated best usages of the waterway, the State's antidegradation policy, and any other relevant water quality related standards, such as endangered species laws.[4]

Notably, Entergy's "current," i.e. administratively extended 1987 § 402 SPDES permit does not demonstrate Indian Point is currently, or will be, in compliance with all applicable State standards, as required by CWA § 401. Indeed, simply operating pursuant to a SPDES permit does not automatically ensure that a permittee is in compliance and will remain in compliance with all relevant requirements.[5] This is exemplified by the situation at Indian Point, where, despite the fact that Entergy holds a SPDES permit, the continued operation of the plant results in violations of various numerical and narrative water quality standards.[6] Moreover, as CWA §

---

[4] *See PUD No. 1 v. Washington Dep't of Ecology*, 511 U.S. 700, 711, 714-15 (1994) (holding that § 401(d) expands state authority to enforce any appropriate state standards beyond the specific requirements of the Clean Water Act; finding that the certifying agency has to make sure that the project is "consistent with both components [of the WQS], namely the designated use and the water quality criteria."); *see also Chasm Hydro, Inc. v. State Dep't of Envtl. Conservation*, 14 N.Y.3d 27, 30, 32 (N.Y. 2010) (acknowledging that consistency with designated uses is part of § 401 WQC); *Niagara Mohawk Power Corp. v. State Dep't of Envtl. Conservation*, 82 N.Y.2d 191, 197, 200-01 (N.Y. 1993) (acknowledging that water quality standards consist of both designated uses and numerical criteria, and that the state's job in a § 401 certification review is to ensure compliance with such water quality standards); *Port of Oswego Auth. v. Grannis*, 897 N.Y.S.2d 736, 739 (N.Y. App. Div. 2010) (acknowledging that § 401 WQC requires ensuring that waters will not be impaired for their best usages); *In re Application for a SPDES Permit by Mirant Bowline*, 2002 N.Y. ENV LEXIS 22, *46 (2002) (DEC, in the context of issuing a permit for an electric generating facility using a cooling water intake structure, acknowledging that EPA had recognized that under § 401, a state may impose requirements "necessary to ensure attainment of water quality standards, including *designated uses*, criteria, and antidegradation requirements.") (emphasis added); *In re Application of Erie Boulevard Hydropower, L.P., for a 401 Water Quality Certification for the School Street Project*, 2000 ENV LEXIS 88, *4 (2000) (acknowledging the holding in *PUD* that a State may impose conditions on 401 certifications insofar as necessary to enforce a designated use contained in the State's water quality standard); U.S. Environmetnal Protection Agency, Office of Wetlands, Oceans, and Waterscheds, *Clean Water Act Section 401 Water Quality Certification: A Water Quality Protection Tool for States and Tribes* (April 2010 Interim), http://water.epa.gov/lawsregs/guidance/cwa/upload/CWA_401_Handbook_2010_Interim.pdf (hereinafter cited as "EPA Water Quality Protection Tool"), at 18, 21 (EPA explaining that once a CWA § 401 is triggered, "the scope of analysis . . . can be quite broad" and acknowledging that "[a]nother relevant consideration when determining if granting 401 certification would be appropriate is the existence of state or tribal laws protecting threatened and endangered species, particularly where the species plays a role in maintaining water quality or if their presence is an aspect of a designated use.").

[5] 6 NYCRR § 750-2.1(b) ("*Satisfaction of permit provisions notwithstanding, if operation pursuant to the permit causes or contributes to a condition in contravention of State water quality standards or guidance values, or if the department determines that a modification of the permit is necessary to prevent impairment of the best use of the waters or to assure maintenance of water quality standards* or compliance with other provisions of ECL Article 17, or the Act or any regulations adopted pursuant thereto (see section 750-1.24 of this Part), *the department may require such a modification* and the Commissioner may require abatement action to be taken by the permittee and may also prohibit such operation until the permit has been modified pursuant to section 621.14 of this title.") (emphasis added).

[6] *See generally* Letter from William R. Adriance (Chief Permit Administrator) to Dara F. Gray (Entergy), Re: Joint Application for CWA § 401 Water Quality Certification NRC License Renewal – Entergy Nuclear Indian Point Units 2 and 3 DEC Nos.: 3-5522-00011/00030 (IP2) and 3-5522-00105/00031 (IP3) *Notice of Denial* (April 2, 2010), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/ipdenial4210.pdf; Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Petition for Full Party Status and Adjudicatory Hearing (July 20, 2010), *available at* http://www.riverkeeper.org/wp-content/uploads/2010/07/RK-NRDC-SH-Petition-for-Full-Party-Status-Indian-Point-401-WQC-scanned.pdf. For example, Entergy is not currently in compliance with the New

303 requires States to review and update their water quality standards every three years,[7] certain New York State water quality standards may have been added or changed since the issuance of the last SPDES permit for Indian Point; it is, thus, patently impossible for the State agency to ensure compliance with current State standards by relying on a decades-old permit. As the tribunal assigned to the appeal proceeding related to Entergy's request for a CWA § 401 WQC ruled, the argument "that the existing SPDES permit is sufficient to establish compliance with applicable water quality standards is not persuasive. The fact that the Facilities currently hold a SPDES permit does not ensure that the requirements of CWA Section 401 have been or will be satisfied."[8]

In a similar vein, the fact that a SPDES permit renewal proceeding is currently pending before NYSDEC and will ostensibly result in a renewed SPDES permit at some point in the future, also is not sufficient to demonstrate compliance with CWA § 401 in relation to the proposed license renewal of Indian Point. Such a position simply fails to acknowledge that the CWA § 401 regulatory framework provides for an inquiry that is broader than what is at issue in a NYS SPDES proceeding pursuant to CWA § 402.[9] Given the comprehensive nature of the § 401 process, reliance upon a § 402 discharge permit patently fails to provide the requisite demonstration needed for a WQC to issue. Notably, this reality has borne out in the actual Indian Point state-related proceedings: the Indian Point SPDES permit renewal proceeding and the Indian Point CWA § 401 appeal proceeding do not have complete identity. In the former, the focus is primarily on compliance with the specific water quality standard set forth in 6 NYCRR § 704.5(b), and parallel federal law pursuant to CWA § 316(b), requiring implementation of BTA; in contrast, the inquiry in the CWA § 401 appeal proceeding is broader, and involves a specific assessment of whether the continued operation of Indian Point will violate various designated uses of NYS waters, narrative water quality standards, and other relevant State laws.[10] In sum,

---

York State requirement that all cooling water intake structures "reflect the best technology available ["BTA"] for minimizing adverse environmental impact." 6 NYCRR § 704.5(b). Entergy's "current" permit, originally issued about 25 years ago, was premised upon the Hudson River Settlement Agreement ("HRSA"), which allowed the owners of Indian Point to essentially defer installing what had been determined to be BTA, that is, closed-cycle cooling. While the HRSA subsequently expired, due to a series of administrative renewals, Indian Point has continued to operate pursuant to the 1987 SPDES permit, which did not mandate the installation of closed-cycle cooling. Thus, Entergy is not in compliance with existing legal requirements, notwithstanding the fact that it technically holds a SPDES permit. This is underscored by the fact that in 2003, DEC initiated a SPDES permit modification, currently pending, in order to ensure that Entergy comes into compliance with the BTA requirement and install a closed-cycle cooling system at Indian Point, precisely as New York State's regulations envision. *See* 6 NYCRR § 750-2.1(b).

[7] 33 U.S.C. § 1313.

[8] In the Matter of the Application of Entergy Indian Point Unit 2, LLC and Entergy Indian Point Unit 3, LLC for a Water Quality Certificate Pursuant to Section 401 of the Federal Clean Water Act and Section 608.9 of Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York, Ruling on Proposed Issues for Adjudication and Petitions for Party Status, DEC Application Nos. 3-5522-00011/00030 (IP2) and 3-5522-00105/00031 (IP3) (December 13, 2010), at 20, 21, *available at*, http://www.dec.ny.gov/hearings/70809.html ("Issues Ruling").

[9] *See supra* note 4; *see also* Issues Ruling, *supra* note 8 at 21 (DEC tribunal ruling that "[a]s [DEC] Staff and Riverkeeper observed, the CWA Section 401 inquiry is necessarily broader than the inquiry undertaken in connection with the Facilities' SPDES permit renewal and modification.").

[10] *See generally* Issues Ruling, *supra* note 8. For purposes of moving forward to an adjudicatory hearing, the proceedings were joined in a narrow respect, i.e., for the limited purpose of developing a joint record for instances

abiding by the ultimate outcome of an ongoing Indian Point SPDES proceeding does not provide the requisite demonstration that a 20-year operating license extension of Indian Point will comply with all relevant New York State standards and is not an appropriate substitute for the comprehensive assessment required by CWA § 401.

Likewise, a previously issued WQC for Indian Point cannot serve to demonstrate compliance with CWA § 401 in relation to the proposed relicensing of the plant. In particular, the last WQC issued for Indian Point, i.e., a 1982 certification, was premised upon the now-expired Hudson River Settlement Agreement, and, as a result, did *not* include an independent determination of compliance with all relevant water quality standards and other appropriate state laws.[11] In fact, the 1982 certification relies upon a SPDES permit that does not conform to existing legal requirements.[12] Thus, this past WQC does not address the relevant inquiry, and certainly does not prove that the operation of Indian Point *currently* complies, *or will* comply, with all relevant applicable state standards. Entergy must apply for and receive a new § 401 WQC in order to do so.

Overall, applicable law and regulatory requirements, as well as the factual circumstances surrounding the operation of Indian Point plainly dictate that a *new* WQC pursuant to CWA § 401 is necessary in order for Entergy to obtain extended operating licenses for Units 2 and 3.

<u>The State of New York has Affirmatively and Timely Denied Entergy's Request for a New CWA § 401 WQC</u>

Riverkeeper supports and reiterates the State's explanation that in relation to the proposed license renewal of Indian Point, the record unambiguously establishes that on April 2, 2010, NYSDEC affirmatively denied Entergy's request for the required *new* CWA § 401 WQC.[13] As such, there has been *no waiver* of the requirements of CWA § 401, contrary to the gross mischaracterizations made by Entergy to the NRC via letter dated June 21, 2011.[14]

As Riverkeeper explained via a letter to Brian E. Holian (Director of License Renewal) dated June 28, 2011,[15] the requirements of CWA § 401 may only be deemed waived when the State

---

where evidence was common to both proceedings. *See* Memorandum from Maria E. Villa (Administrative Law Judge) to Service List, Re: Entergy Indian Point SPDES Proceeding/Section 401 Permit Proceeding (July 15, 2011) at 4.

[11] *See supra* note 6.

[12] *See id.*

[13] *See* Letter from William R. Adriance (Chief Permit Administrator) to Dara F. Gray (Entergy), Re: Joint Application for CWA § 401 Water Quality Certification NRC License Renewal – Entergy Nuclear Indian Point Units 2 and 3 DEC Nos.: 3-5522-00011/00030 (IP2) and 3-5522-00105/00031 (IP3) *Notice of Denial* (April 2, 2010), *available at*, <u>http://www.dec.ny.gov/docs/permits_ej_operations_pdf/ipdenial4210.pdf</u>.

[14] Letter NL-11-073, from Fred Dacimo, Vice President Operations License Renewal, Entergy Nuclear Northeast, to Brian E. Holian, Director, License Renewal, U.S. Nuclear Regulatory Commission (June 21, 2011), at 2, ADAMS Accession No. ML11175A165.

[15] Letter from Deborah Brancato (Riverkeeper) to Brian E. Holian (Director of License Renewal, US NRC), Re: Indian Point Nuclear Generating Unit Nos. 2 & 3, Docket Nos. 50-247 and 50-286 (Clean Water Act § 401 Water Quality Certification) (June 28, 2011) (no apparent ADAMS Accession No.).

agency "fails or refuses to act on a request for certification, within a reasonable period of time (which shall not exceed one year) . . . .".[16] In relation to the proposed federal operating license renewal of the Indian Point nuclear power plant, DEC received Entergy's application for § 401 certification on April 6, 2009. Less than a year later, on April 2, 2010, DEC *acted upon* this request by denying Entergy's application due to a number of violations of State water quality standards and other applicable State laws resulting from the proposed activity.[17] This action did not constitute a "proposed" denial and it is clear that DEC acted in precisely the manner contemplated by the plain language of the statute and controlling precedent and guidance.[18]

Entergy subsequently *chose* to dispute DEC's action and request a hearing in the matter. However, this has no bearing whatsoever on whether DEC properly acted upon Entergy's application within the statutory one-year time limit. Indeed, a hearing on a CWA § 401 determination is not mandated by New York State law, and had Entergy chosen not to take advantage of the administrative hearing process, there would be no possible question that DEC acted upon the § 401 application within the required one-year timeframe. As one State court aptly explains:

> Although the [applicant] had every right to pursue a review, we do not construe [CWA] section 401 as contemplating that an applicant may benefit from the running of the one year period while review is taking place, at the applicant's instance, of the denial of certification by the entity that is statutorily designated to make that decision.[19]

---

[16] 33 U.S.C. § 1341(a)(1).

[17] As explained by DEC Commissioner Martens via letter dated June 23, 2011, DEC Chief Permit Administrator William Adriance, who issued the denial of Entergy's request for CWA § 401 WQC, is duly authorized to act on § 401 applications. Letter from Joseph J. Martens (DEC) to Brian E. Holian (NRC), Re: Indian Point License Renewal, Docket Nos. 50-247, 50-286, State of New York Denial, Clean Water Act Section 401 Water Quality Certification (June 23, 2011), at 1-2, ADAMS Accession No. ML11187A054.

[18] For example, EPA's CWA § 401 Handbook delineates the four options available to certifying agencies when reviewing a request for § 401 certification: "grant, condition, deny *or* waive." EPA Water Quality Protection Tool, *supra* note 4, at 9, 11 ("The central component of §401 certification is the state or tribe's decision to grant, condition, deny *or* waive certification. . . . States and tribes are authorized to waive §401 certification, either explicitly, through notification to the applicant, or by the certification agency not taking action) (emphasis added). Clearly, DEC took an appropriate action by denying the CWA § 401 certification request within the statutory time limit. Moreover, the time limit set forth in CWA § 401 "was meant to ensure that 'sheer inactivity by the State . . . will not frustrate the Federal application.'" *Alcoa Power Generating, Inc. v. FERC*, 2011 U.S. App. LEXIS 9041, *25 (D.C. Cir. 2011) (citing House Conference Report, H.R. Rep. 91-940) ("[T]he purpose of the waiver provision is to prevent a State from indefinitely delaying a federal licensing proceeding by failing to issue a timely water quality certification under *Section 401*"); *see also Little Lagoon Pres. Soc'y, Inc. v. United States Army Corps of Eng'rs*, 2008 U.S. Dist. LEXIS 66557, *70 (S.D. Ala. Aug. 29, 2008) ("Congress built a waiver mechanism into the CWA [§ 401] to prevent state agencies from exercising a pocket veto by sitting on certification requests indefinitely without making a decision, leaving the proposed project to die on the vine). This is clearly not the case here, where DEC actively sought necessary information in order to perform the appropriate assessment pursuant to CWA § 401, and then ultimately made a formal determination on Entergy's application on April 2, 2010.

[19] *City of Klamath Falls v. Envtl. Quality Comm'n.*, 119 Or. App. 375, 377-78, 851 P.2d 602, 604 (Or. Ct. App. 1993); *see also FPL Energy Main Hydro LLC v. Dept. of Envtl. Prot.*, 2007 Me. 97, 926 A.2d 1197, 1203 (Supreme Judicial Court of Maine, 2007), *cert denied* 128 S. Ct. 911 (2008) (stating that "[t]here is no indication . . . that

If this rationale did not prevail, project applicants could make calculated moves to avoid the requirements of CWA § 401 altogether by essentially extending the process to force a manufactured waiver. This would completely contravene the entire purpose of CWA § 401, and deny States their right and authority to perform an assessment of whether or not proposed federal projects comply with relevant State regulations, laws, and standards. It is, thus, clear that the administrative hearing process does not have to be completed in order for DEC's April 2, 2010 denial to be considered the requisite "action" on Entergy's CWA § 401 application.[20]

Thus, the requirements of CWA § 401 have clearly not been waived in relation to the proposed relicensing of Indian Point.

The Necessity of a CWA § 401 WQC Has Been Raised in the Indian Point License Renewal Proceeding

Lastly, as discussed in the State's July 25, 2012 letter, the record in the Indian Point license renewal proceeding before the NRC clearly reflects the fact that Entergy currently lacks, and must obtain, a CWA § 401 WQC prior to obtaining extended operating licenses for Units 2 and 3.

Indeed, since the inception of the proceeding, all parties involved have, at various junctures, acknowledged and discussed the necessity for and/or status of Entergy's application for a CWA § 401 WQC to support the proposed relicensing of Indian Point. This includes, but is not limited to, the following:

- In Entergy's Environmental Report, submitted as part of Entergy's License Renewal Application dated on or about April 30, 2007, Entergy acknowledged that "NYSDEC has taken the position that it will require submission of an application for a *new* state water quality (401) certification in conjunction with the license renewal application" and that "[t]o initiate the approval process, Entergy will file the Joint Application for Permit with the NYSDEC for the water quality certification at a date determined by the NYSDEC";[21]
- In NRC Staff's draft supplemental environmental impact statement concerning Indian Point license renewal, dated December 2008, NRC Staff discussed NYSDEC's authority to make a determination relating to a water quality certification for the Indian Point license renewal proceeding;[22]

Congress intended for all in-state appeals to be completed within the same [CWA] one-year deadline. If Congress intended to impose such extreme time pressure, it would have used specific language to that effect.").

[20] *See, e.g., Alcoa Power Generating, Inc. v. FERC*, 2011 U.S. App. LEXIS 9041, *29 (D.C. Cir. 2011) ("Nowhere in *Section 401* is it stated that a certification must be fully effective prior to the one-year period much less prior to licensing; it requires only that a State 'act' within one year of an application and that a certification be 'obtained.'").

[21] Entergy's License Renewal Application, Appendix E, Applicant's Environmental Report § 9.4, *available at* http://www.nrc.gov/reactors/operating/licensing/renewal/applications/indian-point/2-ipec-lra-appendix-e_3-9.pdf.

[22] Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 1, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50–247 and 50–286 (December 2008) at 4-8.

- Via letter dated April 19, 2010, NYSDEC informed the ASLB about NYSDEC's April 2, 2010 denial of Entergy's request for a CWA § 401 WQC;[23]

- During a conference call among the parties to the Indian Point license renewal proceeding convened on April 19, 2010, a representative of Riverkeeper informed the tribunal about NYSDEC's April 2, 2010 denial of Entergy's request for a CWA § 401 WQC; notably, the ASLB indicated that it could not speak to the impact of DEC's denial on the license renewal proceeding;[24]

- In NRC Staff's final supplemental environmental impact statement concerning Indian Point license renewal, dated December 2010, NRC Staff, at various locations, discussed NYSDEC's April 2, 2010 denial of Entergy's request for a CWA § 401 WQC, Entergy's request for a hearing related to that determination, and how "the matter will be decided through NYSDEC's hearing process;[25]

- On May 26, 2011, NYSDEC submitted comments to NRC on NRC Staff's final supplemental environmental impact statement concerning Indian Point license renewal; these comments discussed NYSDEC's April 2, 2010 denial of Entergy's request for a CWA § 401 WQC and NRC Staff's failure to adequately acknowledge the impact of this denial;[26]

- On June 23, 2011, in response to a letter from Entergy concerning an alleged waiver of the requirements of CWA § 401 in the Indian Point case (dated June 21, 2011), NYSDEC Commissioner Martens submitted a letter to the NRC Director of License Renewal reiterating NYSDEC's position that CWA § 401 requires a WQC in relation to the relicensing of Indian Point, and explaining how the State of New York clearly denied Entergy's application for such a WQC and had not waived its opportunity make a CWA § 401-related determination;[27]

- On June 28, 2011, Riverkeeper submitted a letter to the NRC Director of License Renewal, likewise in response to Entergy's allegations regarding waiver, explaining

[23] Letter from J.L. Matthews (DEC) to ASLB, Re: License Renewal Proceeding for Indian Point Nuclear Generating Station, Unit 2 and 3, Docket Nos. 50-247 and 50-286, ASLBP No. 07-858-03-LR-BD01 (April 19, 2010).

[24] Transcript, Indian Point Prehearing Conference (Apr. 19, 2010), 899:15 – 900:1, ADAMS Accession No. ML101160416.

[25] Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 1, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Docket Nos. 50–247 and 50–286 (December 2010), *available at* http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/supplement38/, at xv ("Two state-level issues (consistency with State water quality standards, and consistency with State coastal zone management plans) need to be resolved. On April 2, 2010, the New York State Department of Environmental Conservation (NYSDEC) issued a Notice of Denial regarding the Clean Water Act Section 401 Water Quality Certification. Entergy has since requested a hearing on the issue, and the matter will be decided through NYSDEC's hearing process."); *see id.* at xvii-xviii, 1-8, 2-27, 4-8 to 4-9, 4-30, 8-3, 9-5, A-151.

[26] New York State Department of Environmental Conservation Comments on the NRC Staff's Final Supplemental Environmental Impact Statement (May 26, 2011), ADAMS Accession No. ML11159A236.

[27] Letter from Commissioner Joseph J. Martens (DEC) to Brian E. Holian (NRC) (June 23, 2011), ADAMS Accession No. ML11187A054.

NYSDEC's clear denial of Entergy's application for CWA § 401 WQC and how the State had not waived any rights with respect to CWA § 401;[28]

- On July 15, 2011 and August 11, 2011, in response to additional correspondence from Entergy, NYSDEC again submitted letters to the NRC Director of License Renewal reiterating Entergy's obligation to obtain a WQC pursuant to § 401, and NYSDEC's explicit denial of Entergy's request for the necessary certification;[29]
- In response to an ASLB request for information about matters that may affect the hearing schedule in the Indian Point license renewal proceeding, on February 9, 2012, Riverkeeper informed the ASLB about the ongoing nature of the CWA § 401 WQC proceeding.[30] In response to the same request, the State informed the ASLB that an issue that may impact the hearing schedule in the proceeding was the fact that Entergy must obtain the necessary CWA § 401 WQC *before* NRC may issue renewed operating licenses, and that Entergy had yet to do so since NYSDEC had denied Entergy's application for such a certification;[31]

Thus, the parties in the Indian Point proceeding have amply presented and reserved the well-supported position that compliance with CWA § 401 is a prerequisite for the relicensing of Indian Point, and that Entergy has yet to obtain the necessary WQC.

For the reasons described in the State's July 25, 2012 letter and above, Riverkeeper concurs with the State that, to the extent it is now necessary in light of the D.C. Circuit court's recent ruling, the Commission is on notice of its responsibility to ensure that Entergy acquires a new CWA § 401 WQC prior to NRC issuing renewed operating licenses for the Indian Point reactors.[32]

---

[28] Letter from Deborah Brancato (Riverkeeper) to Brian E. Holian (Director of License Renewal, US NRC), Re: Indian Point Nuclear Generating Unit Nos. 2 & 3, Docket Nos. 50-247 and 50-286 (Clean Water Act § 401 Water Quality Certification) (June 28, 2011) (no apparent ADAMS Accession No.).

[29] Letter from John L. Parker (DEC) to Brian E. Holian (NRC), (July 15, 2011), ADAMS Accession No. ML11200A052; Letter from John Parker (DEC) to Brian E. Holian (NRC) (August 11, 2011) (ADAMS Accession No. ML11305A021).

[30] Riverkeeper, Inc.'s Response to Atomic Safety and Licensing Board Request for Information (February 9, 2012), at 3, ADAMS Accession No. ML12040A354.

[31] State of New York Response to Board's Request for Information (February 9, 2012), ADAMS Accession No. ML12040A356.

[32] Please note, this letter is not intended to constitute a concession or acknowledgement that the Commission properly has jurisdiction to make determinations with respect to a license renewal applicant's compliance with CWA § 401, but is instead offered to clarify relevant facts and circumstances in light of the recent appellate court decision. Indeed, it is Riverkeeper's position that decisions relating to CWA § 401 are not properly within the purview of the NRC, but rather, are solely within the authority of the State, as a specific right granted by the U.S. Congress. *See S.D. Warren Co. v. Maine Bd. of Envtl. Prot.*, 547 U.S. 370, 373, 385 (2006) (describing CWA § 401 as the prime bulwark" of the cooperative federalism scheme envisioned by the United States Congress in the CWA and as essential for preserving critical state authority over relevant water quality related issues).

Thank you for your consideration.

Respectfully submitted,

<u>Signed electronically by Deborah Brancato</u>
Deborah Brancato
Staff Attorney

<u>Signed electronically by Phillip Musegaas</u>
Phillip Musegaas, Esq.
Hudson River Program Director

cc: Indian Point Service List via NRC EIE

Riverkeeper Amended Contention RK-EC-8A:

Attachment 8

Gallagher, Carol

From: Deborah Brancato <DBrancato@riverkeeper.org>
Sent: Monday, April 29, 2013 3:16 PM
To: Gallagher, Carol
Cc: Phillip Musegaas
Subject: Riverkeeper Supplemental Letter on NRC Draft IP SEIS, Vol. 4
Attachments: Riverkeeper Supplemental Letter on NRC Draft IP SEIS, Vol. 4.pdf

Ms. Gallagher,

Attached please find a supplemental comment on behalf of Riverkeeper in relation to Docket ID NRC-2008-0672 (NRC's Draft FSEIS Vol. 4 concerning the proposed license renewal of Indian Point).

Because the comment period is over, Riverkeeper was not able to upload these comments via regulations.gov. Instead, I have faxed these comments per the initial instructions provided with the publication of NRC's draft report for comment, and I am sending this e-mail as well, to ensure that the attached comments become part of the record pertaining to this matter.

Please do not hesitate to contact me should you have any questions concerning this transmittal.

Sincerely,

7/4/2012
77FR 40091

10

RECEIVED
2013 APR 30 PM 1:23
RULES AND DIRECTIVES BRANCH USNRC

Deborah Brancato, Esq.
Staff Attorney

Riverkeeper, Inc.
20 Secor Road
Ossining, New York 10562
P: (914) 478-4501 x230
F: (914) 478-4527
www.riverkeeper.org

RIVERKEEPER.
NY's clean water advocate

SUNSI Review Complete
Template = ADM – 013
E-RIDS= ADM-03
Add= M. Wentzel (MJW2)

RIVERKEEPER.
NY's clean water advocate

VIA FAX AND E-MAIL

April 29, 2013

Cindy Bladey
Chief, Rules, Announcements, and Directives Branch
Division of Administrative Services
Office of Administration
Mail Stop: TWB-05-B01M
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Carol.Gallagher@nrc.gov

Re: *Docket ID NRC-2008-0672* – Riverkeeper, Inc.'s Supplemental Letter Regarding the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50–247 and 50–286 (June 2012)

Dear Rules, Announcements, and Directives Branch Chief:

Riverkeeper, Inc. ("Riverkeeper") hereby respectfully submits the following supplemental comments on the U.S. Nuclear Regulatory Commission Staff's ("NRC Staff") Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment (hereinafter referred to as "Draft FSEIS Supplement"). Notice of availability of, and opportunity to comment on, the Draft FSEIS Supplement was published on June 26, 2012; this notice provided a public comment period that ended on August 20, 2012.[1] Riverkeeper submitted comments on the Draft FSEIS Supplement in accordance with this deadline and the guidelines established in the public notice related to the document.[2]

Riverkeeper's comments included a discussion of the NRC's Endangered Species Act ("ESA") § 7 consultation with the National Marine Fisheries Service ("NMFS") regarding the proposed

[1] *See* Letter from David J. Wrona (NRC) to U.S. Environmental Protection Agency Office of Federal Activities NEPA Compliance Division EIS Filing Section, Re: Notice of Availability of Draft Supplement to Final Plant Specific Supplement 38 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3 (June 26, 2012), ADAMS Accession No. ML12159A495 (indicating a comment period extending to August 20, 2012).
[2] Riverkeeper Comments on NRC Staff Indian Point Draft FSEIS Supplement (Aug. 20. 2012), *available at*, http://www.regulations.gov/#!documentDetail;D=NRC-2008-0672-0020.

www.riverkeeper.org • 20 Secor Road • Ossining, New York 10562 • t 914.478.4501 • f 914.478.4527

license renewal of Indian Point, which, at the time, remained ongoing.[3] *Subsequent* to the conclusion of the comment period on the Draft FSEIS Supplement, on or about January 30, 2013, the ESA § 7 consultation process officially concluded with the publication of a final Biological Opinion pertaining to the proposed license renewal of Indian Point by NMFS ("Final BiOp").[4]

Although the comment period on the Draft FSEIS Supplement is no longer open and, in fact, NRC expects to issue a finalized FSEIS supplement imminently, Riverkeeper submits this supplemental comment in order to make our position regarding the effect of NMFS' January 30, 2013 Final BiOp clear on the record. In particular, NMFS' Final BiOp focuses solely on potential impacts of ongoing operations of Indian Point on endangered aquatic resources, *as the plant currently operates*, notwithstanding the fact that Entergy wishes to operate the plant in a wholly different manner—with the operation of a cylindrical wedgewire screen technology—which will result in significant impacts to endangered species in the Hudson River. For all of the reasons explained at length in comments Riverkeeper submitted to NMFS on a draft of the BiOp, attached hereto as Attachment 1, NMFS' assessment and conclusions, as ultimately memorialized in the Final BiOp, are questionable in light of the circumstances.[5] Thus, Riverkeeper does not believe that the issuance of NMFS' Final BiOp is dispositive for purposes of NRC's conclusions regarding impacts to endangered species in the Indian Point FSEIS.

Furthermore, in light of the timing of the issuance of NMFS' BiOp, i.e., *after* NRC's publication of the Draft FSEIS, Riverkeeper reserves the right to assert the positions taken in our previously submitted comments regarding the adequacy of NRC's treatment and consideration of ESA § 7 consultation process in the environmental review process related to the proposed license renewal of Indian Point pursuant to NEPA.[6]

Thank you for accepting the foregoing comment into the record relating to NRC's Draft FSEIS Supplement. Should you have any questions regarding this correspondence, please do not hesitate to contact the undersigned.

Respectfully submitted,

Deborah Brancato

Deborah Brancato
Staff Attorney

Phillip Musegaas, Esq.
Hudson River Program Director

---

[3] *Id.* at 6-12.
[4] NMFS Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, Units 2 and 3, pursuant to existing and proposed renewed operating licenses, NER-2012-2252 (Jan. 30, 2013), *available at*, http://pbadupws.nrc.gov/docs/ML1303/ML13032A569.pdf.
[5] Comments of Riverkeeper on NMFS' 10/26/12 Draft Biological Opinion for Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (Nov. 23, 2012) (Attachment 1).
[6] *See* Riverkeeper Comments on NRC Staff Indian Point Draft FSEIS Supplement (Aug. 20. 2012), *available at*, http://www.regulations.gov/#!documentDetail;D=NRC-2008-0672-0020 at 6-12.

Attachment 1

to

Riverkeeper's Supplemental Letter Regarding the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Vol. 4, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment, Docket Nos. 50–247 and 50–286 (June 2012)

RIVERKEEPER.
NY's clean water advocate

November 23, 2012

VIA U.S. MAIL AND ELECTRONIC MAIL

John K. Bullard
Regional Administrator
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
john.bullard@noaa.gov

Julie Crocker
Fisheries Biologist
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
julie.crocker@noaa.gov

Julie Williams
Attorney-Advisor
National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, MA 01930
julie.williams@noaa.gov

Re: NMFS' 10/26/12 Draft Biological Opinion for Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252

Dear Ms. Kurkul, Ms. Crocker, & Ms. Williams:

Please accept the following comments on behalf of Riverkeeper, Inc. ("Riverkeeper") regarding National Marine Fisheries Service's ("NMFS") draft Biological Opinion ("draft BiOp") on the effects of the proposed continued operation of Indian Point Nuclear Generating Station ("Indian Point") Units 2 and 3 on endangered aquatic resources in the significant and historic Hudson River, dated October 26, 2012. While initial Endangered Species Act ("ESA") § 7 consultations regarding the proposed relicensing of Indian Point commenced in December 2010, considered the impacts of the operation of Indian Point on endangered shortnose sturgeon, and resulted in the issuance of a final Biological Opinion on October 14, 2011, formal consultation was reinitiated in May 2012 in light of the recent listing of Atlantic sturgeon as endangered on February 6, 2012. NMFS' new draft BiOp considers the impact of Indian Point on the Atlantic sturgeon, which occur in the Hudson River and are known to be affected by the operation of the plant, and, when finalized, will amend and supersede the agency's previous final BiOp relating to this matter.

Riverkeeper is a non-profit environmental watchdog organization that is committed to the protection of the aquatic ecology of the Hudson River, including endangered shortnose sturgeon and Atlantic sturgeon that reside in the river. To this end, Riverkeeper has historically been engaged in advocacy activities and legal actions involving Indian Point, and, as you are likely aware, is currently a party to the Indian Point operating license renewal proceeding pending before the U.S. Nuclear Regulatory Commission ("NRC"), the Indian Point State Pollutant Discharge Elimination System ("SPDES") permit renewal proceeding, and the Indian Point Clean Water Act ("CWA") § 401 Water Quality Certification ("WQC") appeal proceeding, all of which implicate and involve endangered species issues. Moreover, Riverkeeper retains and regularly consults with the renowned expert fisheries biologists of Pisces Conservation Ltd., on issues pertaining to the aquatic ecology of the Hudson River, and impacts of power plant cooling water intake structures thereto. Riverkeeper is, therefore, well situated to provide feedback on the draft BiOp. Furthermore, consideration of Riverkeeper's comments on NMFS' draft BiOp is both necessary and appropriate pursuant to basic tenets of fairness, due process, and the Federal government's commitment to openness, transparency, and public participation.[1] Notably, during NRC and NMFS' initial ESA § 7 consultation relating to the proposed relicensing of Indian Point, upon Riverkeeper's request, NMFS provided a copy of the draft BiOp, and Riverkeeper greatly appreciated the opportunity to review it and provide NMFS with relevant and important comments.[2] Riverkeeper thanks NMFS in advance for once again accepting and considering the comments submitted herein prior to any issuance of a final Biological Opinion ("final BiOp").

In particular, Riverkeeper respectfully submits the following comments and concerns relating to NMFS' new draft BiOp:

The Usefulness of Issuing a Final BiOp at this Time

As discussed in Riverkeeper's comments on NMFS' previous draft BiOp, Riverkeeper continues to question the appropriateness and efficacy of issuing a final BiOp at this time, in light of the uncertain status of ongoing State legal proceedings involving Indian Point.

[1] The opportunity to review and comment on the draft BiOp would facilitate Riverkeeper's ability to meaningfully participate in the aforementioned ongoing legal proceedings involving Indian Point and to act as a public advocate, as well as foster an open process that Federal agencies are obligated to strive for. Moreover, given that Riverkeeper's position in various Indian Point proceedings is adverse to that of the owner of Indian Point, Entergy Nuclear Operations, Inc. ("Entergy"), and the NRC, it is patently unfair to allow a one-sided external review of the draft BiOp by only Entergy and the NRC.

[2] *See* Letter from D. Brancato (Riverkeeper) to P. Kurkul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011). Indeed, Riverkeeper's comments raised issues that NMFS considered (albeit, not entirely) prior to finalizing its BiOp concerning shortnose sturgeon, including whether accidental radiological leaks from Indian Point had impacted the endangered species in the Hudson River as well as the impact of the Indian Point Unit 1 cooling water intake on shortnose sturgeon – issues for which NMFS' initial draft BiOp was completely silent. *See id.* at 7-9; *see generally* Endangered Species Act Section 7 Consultation DRAFT Biological Opinion - Relicensing - Indian Point Nuclear Generating Station, F/NER/2009/00619; endangered Species Act Section 7 Consultation Biological Opinion - Relicensing - Indian Point Nuclear Generating Station, F/NER/2009t00619, at 49-51, 62.

During NMFS' earlier consultations, NMFS asked NRC to consider withdrawing its request for ESA § 7 consultation until the uncertainties related to the continued operations of Indian Point were resolved.[3] However, per NRC's request, NMFS "completed consultation, considering effects of the proposed action, as defined by NRC staff in the FEIS and BA,"[4] i.e., in relation to existing operations of the plant pursuant to 1987 SPDES permits. NMFS' new, October 26, 2012 draft BiOp take the same approach: while legal proceedings that will determine what new technology will be required to modify the operation of Indian Point's cooling water intake structures remain ongoing, NMFS again only considered "the effects of the operation of IP2 and IP3 pursuant to the . . . [1987] SPDES permits issued by NYDEC that are already in effect" since "NRC requested consultation on the operation of the facilities under the . . . existing [1987] SPDES permits, even though a new SPDES permit might be issued in the future."[5] Thus, while NMFS recognized that the implementation of technology that Entergy has proposed, cylindrical wedge wire screens, "will affect shortnose and/or Atlantic sturgeon in a manner and to a degree that is very different from the effects"[6] of existing operations, the draft BiOp once again only narrowly considers impacts of the current operations of the plant on endangered species in the Hudson River.

Riverkeeper continues to question the utility of the instant ESA § 7 consultation process. To begin with, because NYDEC has unequivocally denied Entergy a necessary CWA § 401 WQC, it is not clear that Indian Point will even continue to operate, in which case §7 consultation regarding the impact of 20 additional years of operating the plant on endangered species would be unnecessary. Without a new, valid CWA § 401 WQC, Indian Point cannot continue to operate.[7] While NYSDEC's determination to deny Entergy this necessary certification was definitive, and made within the statutory one-year timeframe contemplated by the CWA, Entergy chose to avail itself of an optional hearing process on the decision, and that process is currently ongoing. The likelihood that Indian Point may not continue to operate in the absence of a new WQC renders the usefulness of the instant ESA § 7 consultation process questionable.

Moreover, NMFS' analysis in the draft BiOp considering only *existing* operations pursuant to a 25-year old, outdated, administratively extended SPDES permit, is less than useful. The "current" SPDES permit is presently the subject of a renewal proceeding that will result in the modification of the current permit (since it will require the implementation of the best technology available for minimizing the adverse environmental impacts caused by the current operation of Indian Point's environmentally destructive once-through-cooling water intakes). The analysis and determinations required in NMFS' BiOp necessarily hinge and depend upon the

---

[3] *See* Letter from P. Kurkul (Regional Administrator, NMFS) to D. Wrona (Branch Chief, NRC), Re: Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Oct. 14, 2011), at 1.

[4] *Id.*

[5] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 7, 11.

[6] *Id.* at 11.

[7] *See generally* Letter from D. Brancato (Riverkeeper) to NRC Commissioners, Re: Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-247-LR 50-286-LR (July 26, 2012), NRC ADAMS Accession No. ML12208A392.

outcome of that proceeding. It is simply unhelpful (as well as a waste of resources) to issue a final BiOp before the final outcome of the SPDES permit renewal proceeding is known.

The eventual outcomes of the ongoing State proceedings will determine if and how Indian Point might continue to operate, and, thus, more precisely, how the plant would impact endangered species in the Hudson River. NRC's continued request for § 7 consultation regarding a "proposed action" defined as the operation of Indian Point for 20 additional years pursuant to its *existing* (i.e., 1987 administratively extended) SPDES permit remains inappropriate and largely ineffective. As such, Riverkeeper once again opines that issuing a final BiOp at this time that is based on completely inaccurate and irrelevant assumptions is neither appropriate nor useful.

It is advisable and necessary for NRC to either withdraw and hold in abeyance its request for §7 consultation pending the outcome of the State proceedings, *or*, request §7 consultation for a "proposed action" that includes and fully accounts for the reasonably foreseeable differing outcomes of these proceedings, and which will result in a thorough analysis of the respective impacts of such differing outcomes. The State proceedings are indisputably at a point where reasonably foreseeable outcomes are discernible; the likely outcomes of the State proceedings are as follows: (1) Indian Point will no longer continue to operate, (2) Entergy will install and operate a closed-cycle cooling system and potentially various other measures related to the water intakes at Indian Point, or (3) Indian Point will continue to operate for 20 years with a once-through cooling water system and cylindrical wedge wire screens.[8]

For example, Entergy's proposal that Indian Point be allowed to continue to operate with the installation of cylindrical wedge wire screens,[9] clearly requires additional analysis, as such screens would undoubtedly impact the benthic environment and shortnose and Atlantic sturgeon in the Hudson River: these screens would require an enormous set of underwater structures -- 144 screens each of 72 inches in diameter, made of a metal alloy with toxicity implications -- that would rest on the floor of the river, where, as NMFS' draft BiOp discusses at length, sturgeon are present for foraging, migrating, avoiding unsuitable thermal temperatures occurring at higher elevations, etc.[10]

---

[8] NRC has and may continue to argue that it would not be appropriate to speculate as to the outcome of the pending State proceedings, especially since, as NRC has repeatedly acknowledged, it does not have jurisdiction over issues related to Indian Point's state water permits. *See* In re Entergy Nuclear Operations, Inc. (Indian Point, Units 2 and 3), 68 NRC 43, *156-57 (2008) ("NRC is prohibited from determining whether nuclear facilities are in compliance with CWA limitations, assessing discharge limitations, or imposing additional alternatives to further minimize impacts on aquatic ecology that are subject to the CWA. . . [T]he NRC has promulgated regulations, specifically 10 C.F.R. § 51.53(c)(3)(ii)(B), to implement these specific CWA requirements that help assure that the Commission does not second-guess the conclusions in CWA-equivalent state permits, or impose its own effluent limitations . . . . It would be futile for the Board to review any of the CWA determinations, given that it is not possible for the Commission to implement any changes that might be deemed appropriate"). However, asking NMFS to perform a relevant analysis (as opposed to a completely irrelevant and useless one) would clearly not conflict with NRC's lack of authority to substantively opine on Indian Point's CWA-related permits. Moreover, as stated above, the State proceedings are clearly at a point where reasonably foreseeable outcomes are apparent.

[9] Riverkeeper maintains that such an outcome would not be in compliance with federal and state law.

[10] Notably, in the state CWA § 401 and SPDES proceedings, Entergy has failed to provide any analysis of the adverse environmental impacts associated with the construction and operation of a 144-screen array in the Hudson River.

In any event, it is axiomatic that NMFS' *relevant* analysis and conclusions must be taken into account in the Indian Point operating license renewal proceeding, and in NRC's ultimate licensing decision. The relicensing proceeding, from which the ESA §7 consultation obligation stems, and associated review processes are occurring now. The ESA §7 consultation is a critical aspect to these reviews. In particular, NMFS' analysis is a critical and necessary component of the National Environmental Policy Act ("NEPA") process in the Indian Point license renewal proceeding. Indeed, the Atomic Safety and Licensing Board ("ASLB") presiding over the Indian Point relicensing case had ruled that "NMFS's BiOp will aid the agency [i.e., NRC] in making its licensing decision in this [relicensing] proceeding. Without receipt and consideration of that input from NMFS, the NRC Staff arguably has not taken the requisite hard look at this issue."[11] As a result, the final environmental impact statement that NRC Staff has already issued in the Indian Point license renewal proceeding, in conjunction with a pending supplement to the final environmental impact statement that has yet to be finalized, will be inadequate without review and consideration of a final BiOp that analyzes all *relevant* issues.

Therefore, whether or not NRC's §7 consultation request is withdrawn until the State proceedings conclude, or whether or not NRC redefines the relevant "proposed action" to ensure an accurate and adequate analysis by NMFS, it is clear that NRC must factor NMFS' ultimate analysis and conclusions into the environmental review process concerning the proposed license renewal of Indian Point, and in the final decision regarding whether to grant renewed licenses for the plant.[12]

---

[11] In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3, Docket Nos. 50-0247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (Ruling on Pending Motions for Leave to File New and Amended Contentions (July 6, 2011), at 69-70.

[12] In the event NRC does not choose either of these options, and proceeds with consultation under the faulty assumption regarding how Indian Point would continue to operate, as NMFS has made clear, re-initiation of consultation will be necessary once the outcome of the State proceedings is known, to account for the inevitable new information and circumstances that will arise. Under such a scenario, NRC, at that time would be obliged to consider NMFS' new/additional analysis and conclusions in the Federal environmental review process concerning the proposed license renewal of Indian Point, and in the final decision regarding whether to grant renewed operating licenses to the facility. For example, as discussed above, should Entergy's proposal to implement cylindrical wedge wire screens at Indian Point ultimately prevail, a new assessment by NMFS would clearly be necessary, as such screens would impact shortnose and Atlantic sturgeon in the Hudson River, which will have to be accounted for in the Federal relicensing case.

Notably, given NRC's noted lack of jurisdiction over CWA-related issues, NRC may choose to not await the outcome of the Indian Point SPDES permit renewal proceeding before attempting to conclude the license renewal proceeding; additionally, while NRC may not issue renewed operating licenses for Indian Point unless the plant receives a valid CWA § 401 WQC, this does not prevent NRC from attempting to finalize and conclude all otherwise required analyses and review processes, or from reaching a determination about the appropriateness of relicensing Indian Point from a safety and environmental perspective, which could be executed in the event a valid §401 certification is issued. However, under no circumstances would it be legal for NRC to in any way preclude consideration of the ESA §7 consultation process in the relicensing proceeding: consideration of NMFS's assessment on endangered species impacts is necessary pursuant to NEPA. *See generally*, Riverkeeper, Inc. Consolidated Motion for Leave to File a New Contention and New Contention Concerning NRC Staff's Final Supplemental Environmental Impact Statement (Feb. 3, 2011), *accessible at*, http://www.nrc.gov/reading-rm/adams.html#web-based-adams, ADAMS Accession No. ML110410362 (proffering a legal contention asserting the insufficiency of NRC's final environmental impact statement for failure to account for the ESA §7 consultation process, which was later deemed a valid and adjudicable issue by presiding ASLB). Therefore, when, in the future, In the event that NRC does not either withdraw and hold in abeyance its request for ESA §7 consultation pending the outcome of the State proceedings, or, request ESA §7 consultation for a redefined "proposed action" to ensure an accurate and adequate analysis by NMFS, and NMFS intends to issue a Final BiOp, Riverkeeper submits the following comments on the new draft BiOp.[13]

NMFS' Incidental Take Statement

NMFS' draft BiOp includes an Incidental Take Statement ("ITS") which exempts the take of 562 shortnose sturgeon impinged by Indian Point Units 1, 2, or 3 intakes throughout the proposed relicensing period, and 219 New York Bight ("NYB") Distinct Population Segment ("DPS") Atlantic sturgeon impinged by Indian Point Units 1, 2, or 3 intakes throughout the proposed relicensing period.[14] NMFS concludes that such losses of sturgeon caused by Indian Point over a proposed 20 period of extended operation are not significant.

Riverkeeper does not agree that such losses are appropriate or acceptable. Notably, sturgeon are an aspect of the designated use assigned to the Hudson River pursuant to the CWA; this designated use dictates that the Hudson River "shall be suitable for fish, shellfish, and wildlife propagation and survival."[15] Moreover, the historical existing use of the Hudson River as a sturgeon fishery is an established fact. The degree and appropriateness of the impact of Indian Point on endangered sturgeon in the Hudson River must be considered in view of these circumstances.[16]

In addition, due to the slow maturation process and intermittent spawning of shortnose and Atlantic sturgeon, (which NMFS' draft BiOp recognizes[17]), *any* impacts on this species may

---

NMFS assesses new, previously unanalyzed information arising out of the ultimate decisions in the now pending State proceedings, this will necessitate a supplemental review and analysis by the NRC in the license renewal proceeding pursuant to NEPA.

[13] Riverkeeper does not repeat, but incorporates by reference the comments previously submitted related to shortnose sturgeon (Letter from D. Brancato (Riverkeeper) to P. Kukul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011)), to the extent they were not adequately addressed or considered in NMFS' previous final BiOp, and, in turn, NMFS' current draft BiOp.

[14] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 119.

[15] 6 NYCRR § 864.6; 6 NYCRR § 701.11.

[16] *See generally* Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Petition for Full Party Status and Adjudicatory Hearing, (July 10, 2010), *accessible at*, http://www.riverkeeper.org/wp-content/uploads/2010/07/RK-NRDC-SH-Petition-for-Full-Party-Status-Indian-Point-401-WQC-scanned.pdf (last visited Nov. 20, 2012) at 31-34. Riverkeeper appreciates and understands the difference between the ESA and the CWA, but respectfully submits that the protections afforded to endangered resources pursuant to the CWA are relevant and important.

[17] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 15, 24, 26.

have noticeable affects, and it is critical that such impacts are kept to a minimum. Fisheries Biologist Dr. Peter Henderson of Pisces Conservation Ltd has provided his expert opinion that these numbers are appreciable, and for "endangered long-lived species," "cannot be considered trivial."[18]

In relation to shortnose sturgeon, as Dr. Henderson explains, the special significance of the Hudson River to the species warrants particular protection.[19] Dr. Henderson points out that favorable recruitment of shortnose sturgeon may not persist given potential climate change impacts and explains the lack of scientific support for the claim that the population of shortnose sturgeon in the Hudson River is stable and at carrying capacity; Dr. Henderson further disagrees with NMFS' conclusion that the proposed relicensing of Indian Point will not necessarily affect the population of shortnose sturgeon in the Hudson River, since Indian Point will undoubtedly contribute to the reduction of the likelihood that individual sturgeons will reach old age; Moreover, Dr. Henderson explains that the lack of information on the range of mortality rates attributable to man and their combined impact on the Hudson River population of shortnose sturgeon is unclear.[20]

In relation to Atlantic sturgeon, Dr. Henderson explains that fate of Atlantic sturgeon in the Hudson River is important since recent spawning information is only known from the Hudson and Delaware rivers.[21] Dr. Henderson does not agree that the impingement of a small proportion of the juvenile population of Atlantic sturgeon will not necessarily jeopardize the continued existence of the species, since impingement mortality and habitat degradation hinder recovery.[22] Dr. Henderson explains that the indication that the population of Atlantic sturgeon is increasing is poor and does not properly ground NMFS' conclusion that the losses attributable to Indian Point are not significant, as well as the fact that, similar to shortnose sturgeon, combined effects related to Atlantic sturgeon are not well-quantified.[23]

Dr. Henderson has further explained to Riverkeeper that it is important to distinguish the impacts of power plant operations from other impacts such as fishing. For example, while there is a tendency to view power stations as another exploiter of a population like fishermen, this is not the case because if the population has a couple of poor recruitment years, it is possible for environmental managers to reduce the hunting take. That is, fishing activity can be actively managed and a response made quickly if a population gets into trouble. On the other hand, nuclear power plants, once given permission to operate, will continue to operate and do harm for many years. It is effectively impossible for the license of such a plant to be revoked or for the output and water use of a plant to be quickly changed because a population is getting into trouble. To the contrary, they are inflexible, and, as a result, cannot contribute to population management. Dr. Henderson has advised Riverkeeper that over long periods of 10-25 years, this

---

[18] Attachment 1 – Memorandum from Pisces Conservation Ltd, "Sturgeon and Indian Point," (Nov. 21, 2012) at 1.

[19] *Id.* at 1-2.

[20] *Id.*

[21] *Id.* at 2.

[22] *Id.*

[23] *Id.*

inflexibility is likely to become important and harmful as all populations will occasionally have hard times. Because of the particularly inflexible and detrimental impacts of power plants, care and caution must be taken over decisions involving such plants.

The expert assessment of Pisces Conservation Ltd clearly reveals that NMFS' conclusions exempting the take of endangered sturgeon in the Hudson River are not adequately founded.

In addition, NMFS' conclusions regarding the prospective impacts to endangered sturgeon from the ongoing, i.e., future, operation of Indian Point are not well-founded due to the fact that they are based on data that was collected over twenty years ago. That is, NMFS drew conclusions without any knowledge about the current *actual* impacts of Indian Point. As a result, NMFS' findings are arbitrary and inherently unreliable. As Dr. Henderson explains, the populations of both shortnose and Atlantic sturgeon have changed since data was collected, as well as plant operations and technical specifications; a notable example is that no sampling has been undertaken since Ristroph screens were installed, resulting in no relevant data on sturgeon survival.[24]

NMFS' Assessment of the Cumulative Impacts to Atlantic Sturgeon[25]

NMFS recognizes that Indian Point has had and (with the continued use of the existing once-through cooling water intake structure) will continue to have adverse impingement impacts on endangered Atlantic sturgeon in the Hudson River.[26] NMFS has concluded the loss of Atlantic sturgeon from the ongoing (existing) operation of Indian Point would "not appreciably reduce the likelihood that the NYB DPS of Atlantic Sturgeon will survive in the wild."[27]

However, it remains questionable whether NMFS has adequately assessed the losses of Atlantic sturgeon in the Hudson River in view of all Atlantic sturgeon entrainment- and impingement-related losses over *all* intakes of all the power plants in the Hudson River and other relevant waters. All of these intakes taken together are authorized to withdraw trillions of gallons of water every year.[28] While NMFS' draft BiOp makes cursory reference to the existence of other

---

[24] *Id.* at 1-2.

[25] Riverkeeper submitted concerns related to the inadequate consideration of cumulative impacts on shortnose sturgeon, which are incorporated by reference into the instant comments. *See* Letter from D. Brancato (Riverkeeper) to P. Kukul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011), at 5-7; *see also* Attachment 1 – Memorandum from Pisces Conservation Ltd, "Sturgeon and Indian Point," (Nov. 21, 2012) at 1-2.

[26] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 14.

[27] *Id.* at 116.

[28] *See, e.g.*, NYSDEC Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System Permits for the Roseton 1 & 2, Bowline 1 & 2 and Indian Point 2 & 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties, Hudson River Power Plants FEIS (June 25, 2003) (hereinafter "2003 DEC Hudson River Power Plants FEIS"), at 71 (Responses to Comments), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP6.pdf (indicating in 2003 that "[t]he sheer volumes of water necessary to meet the HRSA [Hudson River Settlement Agreement] plants' cooling requirements are enormous. Together, Indian Point, Roseton, and Bowline are authorized to withdraw *1.69 trillion* gallons per year for cooling water . . . ") (emphasis added).

impingement related impacts to Atlantic sturgeon in the Hudson River, NMFS presents no analysis of the combined, total cumulative impacts to shortnose sturgeon, and no assessment of whether, *in light of such overall impacts*, the losses caused by Indian Point would appreciably affect the species in the river. As Dr. Henderson of Pisces Conservation Ltd has previously advised, a BiOp without such an analysis is deficient.[29]

In particular, if Indian Point might allegedly kill 219 individual Atlantic sturgeon over the proposed 20 year license renewal period for Indian Point, such losses must be considered as part of an overall loss from *all* water extraction activities. That is, NMFS must assess what losses all power plants combined inflict on Atlantic sturgeon.[30] NMFS' draft BiOp reveals an inadequate sense of the spatial extent of the Hudson River Atlantic sturgeon population or threats facing it.[31] There is a dearth of analysis of the cumulative impacts over the geographical range of this population. In addition, a cumulative impact assessment must also appropriately consider the combined impacts of other projects that affect endangered sturgeon in the Hudson River and NYB DPS, including the Tappan Zee Bridge Replacement Project; as NMFS' draft BiOp indicates, this transportation infrastructure project will result in impacts to endangered sturgeon.[32]

An adequate cumulative impact analysis is necessary in order to arrive at any ultimate conclusions regarding the impact of Indian Point on this endangered species, and, if appropriate, to determine further reasonable and prudent measures necessary to minimize impacts to Atlantic sturgeon. For example, if the combined impacts to Atlantic sturgeon are significant, then each plant must reduce its impact, even if each is not responsible for an appreciable number. NMFS cannot deem the losses caused by Indian Point acceptable in a vacuum, i.e., without putting such

---

[29] *See* Letter from D. Brancato (Riverkeeper) to P. Kukul (NMFS), J. Williams (NMFS), and J. Crocker (NMFS) re: Draft Biological Opinion for License Renewal of the Indian Point Nuclear Generating Unit Nos. 2 and 3 (Sept. 15, 2011),at 5-7; *see also* 2003 DEC Hudson River Power Plants FEIS, at 16, *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP3.pdf ("In addition to impingement and entrainment losses associated with the operation of CWIS, *another concern is the cumulative degradation* of the aquatic environment as a result of: (1) multiple intake structures operating in the same watershed or in the same or nearby reaches; and (2) intakes located within or adjacent to an impaired waterbody. . . . [T]here is concern about the effects of multiple intakes on fishery stocks") (emphasis added); *see also id.* at 54 (Responses to Public Comments), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP5.pdf ("The actual draw-down [i.e., "[t]he direct reduction of the quantity of organisms within the water column by water intakes"] is likely even greater because the three HRSA generating plants (combined with other facilities in the same river reaches) *act cumulatively on the entire aquatic community*") (emphasis added).

[30] It is well known that other power plants impinge and entrain sturgeon, which the draft BiOp acknowledges and describes in part. *See also* NMFS Sturgeon Recovery Plan, at 55 ("The operation of power plants in the upper portions of rivers has the greatest potential for directly affecting sturgeon populations because of the increased incidence of entraining younger and more vulnerable life stages. Documented mortalities of sturgeon have occurred in the Delaware, Hudson, Connecticut, Savannah and Santee rivers. Between 1969 and 1979, 39 shortnose sturgeon were impinged at power plants in the Hudson River (Hoff and Klauda 1979).").

[31] For example, does the population extend into Long Island Sound and other areas of adjacent coast where it is impacted by other intakes?

[32] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12) at 44.

losses into proper context, and determining whether such losses are significant in light of all other relevant impacts to the species.

Similarly, while NMFS has concluded that the thermal plume at Indian Point is not likely to negatively affect Atlantic sturgeon in the vicinity of the plant, NMFS has failed to adequately assess the cumulative impacts of power plant thermal plumes on Atlantic sturgeon.[33] While it may be correct that Atlantic sturgeon will avoid water that is too warm for them, if there are numerous regions with plumes that are being avoided, NMFS must assess what total loss of habitat may be occurring and whether such loss is appreciable for the species in the Hudson River. This is especially important in light of global climate change, which NMFS recognizes will cause the water temperature of the Hudson River to rise over time. NMFS must view the thermal impacts of Indian Point with regard for the broader range of thermal impacts faced (and to be faced) by the species in the river.[34]

NMFS' overall conclusion is that the continued operation of Indian Point during Entergy's proposed 20 year period of extended operation "is not likely to jeopardize the continued existence of" NYB DPS of Atlantic sturgeon.[35] However, given NMFS' failure to properly view the losses of Atlantic sturgeon caused by the operation of Indian Point in light of total impacts to this species in the Hudson River, these conclusions are, as yet, dubious.

NMFS' Failure to Adequately Consider Impacts of Radiological Releases from Indian Point on Endangered Sturgeon

In contrast to NMFS' previous draft BiOp (which omitted any mention, let alone discussion and analysis of radiological discharges from Indian Point), NMFS' new draft BiOp does include a discussion of the potential impact of radionuclides from Indian Point on endangered sturgeon in the Hudson River. However, NMFS' analysis is not adequate to resolve all concerns related to the potential effects on shortnose and Atlantic sturgeon caused by the regular release of radionuclides directly to the Hudson River from Indian Point, as well as the toxic radionuclide laden contamination plumes that underlie the site, which undeniably migrate and release to the Hudson River.

NMFS discusses Entergy's REMP program, as well as a one-time enhanced radiological monitoring study conducted in 2007 (i.e., 5 years ago), and based on this information, concludes that "while shortnose and Atlantic sturgeon may be exposed to radionuclides originating from

---

[33] Riverkeeper has offered comments on the illegality of NYSDEC's proposed issuance of a 75-acre mixing zone to allow the facility to discharge heated effluent to the Hudson and expects that issues related to thermal considerations will be advanced to adjudication.

[34] *See* 2003 DEC Hudson River Power Plants FEIS at 71 (Public Comment Summary), *available at*, http://www.dec.ny.gov/docs/permits_ej_operations_pdf/FEISHRPP6.pdf (indicating in 2003 that "[t]ogether, Indian Point, Roseton, and Bowline are authorized to withdraw 1.69 trillion gallons per year for cooling water, and they discharge 220 trillion BTU of waste heat per year. The volume of once-through cooling water is raised between 15°F and 18°F, depending on the plant, or an average of 16.2°F"); *see also supra* Note 9 (discussing concerns relating to cumulative impacts to aquatic ecology of the Hudson River).

[35] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 117.

Indian Point . . . any exposure is not likely to be at levels that would affect the health or fitness of any individual shortnose or Atlantic sturgeon. . . . Thus, NMFS considers the effects to shortnose and Atlantic sturgeon from radionuclides to be insignificant and discountable."[36] However, NMFS' limited review does not warrant such definitive and sweeping conclusions.

To begin with, it is necessary to clarify that the radiological contamination at Indian Point is not simply the result of past spent fuel pool leaks, which NMFS' draft BiOp seems to imply. In fact, decades of leaks from a variety of components, including the Unit 1 and Unit 2 spent fuel pools, but also underground pipes and structures, and other components, has resulted in extensive plumes of contamination (which contain, *inter alia*, highly toxic strontium-90 and cesium-137, as well as tritium) in the groundwater beneath the Indian Point plant. It is undisputed that this contamination leaches through the bedrock beneath Indian Point, and discharges to the Hudson River.[37] Other critical overlooked and unmentioned facts are that active current radiological leaks occur, future additional leaks are highly likely, and that any such leaks at Indian Point will add to the existing contamination plumes.[38] Entergy's current "remediation" methodology is Monitored Natural Attenuation,[39] and, thus, this contamination will persist in the groundwater and continually be discharged to the Hudson River throughout the proposed period of extended operation, and beyond.

In light of these circumstances, NMFS' assessment of the potential impact of radiological releases from Indian Point on endangered species in the Hudson River in its draft BiOp is wanting. In particular, NMFS has failed to consider cumulative impacts on endangered species due to ongoing and future radiological releases from Indian Point *throughout* the proposed relicensing period. It is undisputed that past fish samples have showed elevated levels of radionuclides, and there is every reason to believe, absent any enhanced and regular fish sampling scheme, that because the groundwater contamination at Indian Point directly discharges to the Hudson River, it may impact fish in the river during the proposed relicensing terms. Even if endangered species in the Hudson River are being exposed to "small" levels of radionuclides, NMFS has demonstrably failed to conduct the assessment necessary to found the sweeping conclusion that any such impacts are "insignificant and discountable." Relying on a *one-time* study that was conducted 5-years ago for an apparent assurance that the radionuclides attributable to Indian Point will not impact endangered resources through 2035 belies logic and science. Moreover, NMFS' reliance on Entergy's REMP program, which involves a relatively limited set of opportunistic sampling that does not involve sampling of bone, where Strontium-

---

[36] *Id.* at 102.

[37] *See* Groundwater Investigation Executive Summary (Indian Point Entergy Center, Buchanan, N.Y., Jan. 2008), at 1 ("The plumes ultimately discharge to the Hudson River to the West").

[38] *See generally*, Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Petition for Full Party Status and Adjudicatory Hearing, (July 10, 2010), *accessible at*, http://www.riverkeeper.org/wp-content/uploads/2010/07/RK-NRDC-SH-Petition-for-Full-Party-Status-Indian-Point-401-WQC-scanned.pdf (last visited Nov. 20, 2012), at 39-48; Post-Hearing Closing Brief of Intervenors Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Regarding Issue for Adjudication No. 3 – Radiological Materials (April 27, 2012), at 24-66.

[39] *See, e.g.*, GZA GeoEnvironmental, Inc., Hydrogeologic Site Investigation Report, Indian Point Energy Center (Jan. 7, 2008) ("The proposed remediation technology is source elimination/control . . . with subsequent Monitored Natural Attenuation, or MNA.")

90 is known to concentrate, is clearly inadequate to support an overall conclusion that radionuclides from Indian Point pose no danger to shortnose and Atlantic sturgeon in the Hudson River for the next 20+ years. Notably, Riverkeeper has questioned the legality of the accidental radiological releases from Indian Point to waters of NYS in State proceedings that are still pending. Those proceeding revealed Entergy's failure to demonstrate that radiological leaks will not adversely impact the aquatic ecology of the Hudson River, which includes endangered sturgeon species, during the proposed relicensing terms.[40]

The lack of adequate analysis by NMFS is particularly troubling given the known dangers of exposure to radioactive substances such as strontium-90 and tritium: Strontium-90 imitates calcium by concentrating in fish bones and shells of clams and blue crab. Clams are a major part of the diet of sturgeon found in the Hudson River. Riverkeeper, therefore, continues to be concerned that Hudson sturgeon are being exposed to elevated levels of this dangerous substance, opine that NMFS' assessment does not resolve these concerns.

In addition, Entergy has indicated that cesium contamination is present in Hudson River sediments in front of Indian Point and that this contamination is attributable in part to releases from Indian Point.[41] Entergy's plans to dredge such sediments in order to install cylindrical wedge wire screens on the river-bottom poses a clear risk to endangered sturgeon from radionuclides from Indian Point. Yet, NMFS has failed to consider such impacts. Notably, Entergy's lack of adequate information on the what levels of contaminants attributable to Indian Point are in the river sediments or how sediment discharges can and should be controlled[42] highlights the potential risks posed to endangered sturgeon species in the river that have not been accounted for.

NMFS' BiOp must properly analyze the potential effects of radiological releases and groundwater contamination at Indian Point on shortnose and Atlantic sturgeon. Assessing this issue is a critical aspect of NMFS' overall assessment of impacts to these endangered species, and should certainly be considered in terms of further necessary and appropriate reasonable and prudent measures that should be implemented at Indian Point. For example, appropriate measures include remediation and mitigation measures to assure that radiological contamination attributable to Indian Point does not discharge to the Hudson River in the first instance, which, according to representations from Entergy, is entirely possible.[43]

---

[40] *See generally* Post-Hearing Closing Brief of Intervenors Riverkeeper, Natural Resources Defense Council, and Scenic Hudson Regarding Issue for Adjudication No. 3 – Radiological Materials (April 27, 2012).

[41] IPEC CWW Dredging Step 1 – Draft White Paper Postulated Contamination Characterization (Nov. 2011). Notably, Riverkeeper filed a motion to reopen the record in the State adjudicatory proceedings to allow meaningful consideration of the information in this report, which came to light after hearings on the relevant issue concluded, in relation to how radiological leaks at Indian Point have impacted, or will impact, the Hudson River. While this motion was denied, the time to appeal the denial is still ongoing; moreover, the State tribunal has indicated that concerns related to the sediment issue can appropriately be raised in the context of hearings related to Entergy's cylindrical wedge wire screen proposal.

[42] *See id.*

[43] In the Matter of: Entergy Nuclear Indian Point 2, LLC, and Entergy Indian Point 3, LLC, For a State Pollution Discharge Elimination System Permit Renewal and Modification, DEC No.: 3-5522-00011/00004, SPDES No.: NY-0004472; Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear

NMFS' Failure to Assess all Reasonable and Prudent Measures

NMFS concludes that potential losses of Atlantic sturgeon caused by Indian Point over a proposed 20 year period of extended operation are not significant, and therefore, exempts a certain level of impingement. As discussed above, NMFS' conclusions are, at a minimum, uncertain, given the extent of the take, and due to NMFS' failure to properly assess the cumulative impacts to sturgeon in the Hudson River. Moreover, Riverkeeper once again respectfully submits that, because of the slow maturation process and intermittent spawning of Atlantic sturgeon, (which NMFS' draft BiOp recognizes[44]), *any* impacts on this species may have noticeable affects, and that it is critical that impacts on Atlantic sturgeon are kept to a minimum.

In any event (that is, whether NMFS' overall conclusions are supportable or whether the impacts may be more significant than the draft BiOp concludes), due to the availability of a technology that would substantially reduce the impacts to Atlantic sturgeon caused by Indian Point, i.e., closed-cycle cooling,[45] Riverkeeper fails to understand why the draft BiOp does not assess the efficacy of this technology as a "reasonable and prudent measure"[46] to be implemented at the plant.

While Riverkeeper understands that the outcome of the NYDEC SPDES permit modification proceeding will ultimately determine whether closed-cycle cooling will be required at Indian Point,[47] there is no reason this should preclude NMFS from examining this technology, and

Operations, Inc. Joint Application for CWA § 401 Water Quality Certification, DEC App. Nos. 3-5522-00011/00030 (IP2), 3-5522-00105/00031, Transcript of Arbitration before Daniel P. O'Connell, ALJ, Maria E. Villa, ALJ, Reporter: Alan H. Brock, RDR, CRR, Farmer Arsenault Brock LLC (January 11, 2012, pages 3071-3344; January 23, 2012, pages 3895-4125), at 4041:2-6, 11-14, 4094:1-2, 18-21.

[44] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 24, 26.

[45] Closed-cycle cooling systems require only a small fraction of the water which is required by once-through cooling systems, and since aquatic mortality is directly related to the amount of water use, a retrofit to a closed-cycle cooling system results in substantial reductions in aquatic mortality. *See* DEC Fact Sheet, New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal With Modification, Indian Point Electric Generating Station, Buchanan, NY – November 2003, at Attachment B, p.3, *available at* http://www.dec.ny.gov/docs/permits_ej_operations_pdf/IndianPointFS.pdf (last accessed Nov. 20, 2012) ("Closed-cycle cooling recirculates cooling water in a closed system that substantially reduces the need for taking cooling water from the River."); *see also, e.g.*, Network for New Energy Choices, *The Truth About Closed-Cycle Cooling* (2010), *available at*, http://www.newenergychoices.org/uploads/fishkill_truth.pdf (last accessed Nov. 20, 2012).

[46] *See* 50 C.F.R. § 402.02 ("*Reasonable and prudent measures* refer to those actions the Director believes necessary or appropriate to minimize the impacts, *i.e.*, amount or extent, of incidental take."); *see id.* § 402.14(g)(8) ("In formulating its biological opinion, . . . and any reasonable and prudent measures, the Service will use the best scientific and commercial data available. . ."); *see also id.* § 402.14(i)(ii) ("the Service will provide with the biological opinion a statement concerning incidental take that: . . . (ii) Specifies those reasonable and prudent measures that the Director considers necessary or appropriate to minimize such impact").

[47] As discussed at length above, in order for the consultation process to be meaningful and useful, NRC should request consultation regarding the reasonably foreseeable outcomes of the ongoing State proceedings, or, in the alternative, withdraw its request for consultation and initiate such consultation in the future after the State proceedings conclude. However, if NRC does not do this, and NMFS and NRC continue the consultation process

reaching independent conclusions about whether instituting this technology would be beneficial for endangered aquatic resources in the Hudson River.

Overall, NMFS' "Reasonable and Prudent Measures" fail to result in a net benefit to the endangered sturgeon populations in the Hudson River and NYB DPS. NMFS' "Reasonable and Prudent Measures" require monitoring of impingement, releasing any live sturgeon back to the river, performing necropsy's on any dead sturgeon, conducting genetic sampling of all impinged sturgeon, and reporting any sturgeon sightings near Indian Point.[48] While these measures are certainly important, altogether they fail to reduce the likely non-trivial impact Indian Point will have on endangered sturgeon in the Hudson River.

NMFS' Conservation Recommendations

Riverkeeper questions the efficacy and sufficiency of NMFS' "Conservation Recommendations" related to the impact of Indian Point on endangered sturgeon in the Hudson River. NMFS recommends that NRC ensure and/or require tissue analysis, impingement/entrainment/heat shock studies, thermal plume model studies, REMP samples of forage species, mortality studies, in-water assessments and abundance/distribution surveys in the Hudson River and Haverstraw Bay in particular, and studies to assess sturgeon interaction with Indian Point's thermal plume.[49]

To begin with, while these recommendations are important and will result in the existence of better information about the impact of Indian Point on endangered aquatic resources, as NMFS explains, such recommendations from NMFS to the NRC are "discretionary agency activities."[50] Riverkeeper questions the degree to which NRC will undertake *any* of NMFS' suggestions, given NRC's historical disinclination to "require" licensees to undertake any activities beyond what is specifically dictated by statutes and regulations. NRC has a noted history of ignoring important environmental considerations related to the operation of Indian Point, while taking the stance that the plant is in compliance with applicable laws and regulations. A level of assurance or plan to ensure that NRC meaningfully considers NMFS' Conservation Recommendations, is, therefore, advisable.

In any event, NMFS' Conservation Recommendations fail to achieve a net conservation benefit to the endangered sturgeon populations in the Hudson River.[51] That is, they demonstrably fail to mitigate the significant impact that Indian Point will have on endangered sturgeon during the proposed relicensing period. There is simply no mitigation plan articulated to ensure that endangered sturgeon are adequately protected during the proposed 20 additional years of operation Entergy is seeking for Indian Point.

---

based on the existing draft BiOp, the efficacy of a closed-cycle cooling system should still be analyzed before finalizing the BiOp.

[48] Endangered Species Act Section 7 Consultation, Draft Biological Opinion, Continued Operations of the Indian Point Nuclear Generating Station, F/NER/2012/02252 (NMFS Draft 10-26-12), at 120-21.

[49] *Id.* at 125.

[50] *Id.*

[51] *Id.*

Thank you for your consideration of the foregoing comments. Please do not hesitate to contact me at 914-478-4501, or via e-mail at dbrancato@riverkeeper.org, to discuss anything further.

Sincerely,

Deborah Brancato

Deborah Brancato
Staff Attorney

cc: Sherwin Turk
Office of General Counsel
Mail Stop: 0-15D21
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
Sherwin.Turk@nrc.gov

ATTACHMENT 1

To: Deborah Brancato (Riverkeeper)

From: Peter Henderson

Date: Wednesday, 21 November 2012

Re: Sturgeon and Indian Point

Summary Comments on NMFS' Draft BiOp

The first point to note is that it is recognised that impingement will kill appreciable numbers of sturgeon: "the continued operation of IP2 and IP3 . . . through the proposed extended license period . . . will result in the impingement and mortality of 562 shortnose sturgeon and 219 juvenile New York Bight DPS Atlantic sturgeon" (Draft BiOp at p.108). For endangered long-lived species, these numbers cannot be considered trivial. Imagine the concern if wind turbines were predicted to kill the same numbers of protected bird species.

A second key point is that all the calculations and predictions are based on data collected prior to 1991. Not only have the populations of both species likely changed since this period, but plant operation and technical specification has also changed. For example, no sampling has been undertaken since the Ristroph screens were installed. There is, therefore, no relevant data on sturgeon survival.

The species are considered in turn below.

Shortnose Sturgeon

The first point to note is the importance of the Hudson to this species. "The Hudson River population of shortnose sturgeon is the largest in the United States." (Draft BiOp at p.108). Given the poor health of many other populations, the Hudson is of special significance and merits particular protection.

Recruitment of this species varies appreciably through time and seems to be linked to conditions in the fall. Recruitment was particularly favourable 1986-1992 and this explains the increased population observed in the late 1990s. However, care must be taken not to assume such favourable recruitment will persist, particularly given potential climate change impacts.

To summarise the Draft BiOp, it concludes that the proposed action will not affect the shortnose sturgeon population because the number killed is a small proportion of the total population. It is claimed that the population is stable and possibly at carrying capacity, however, there is no evidence presented to scientifically support this finding.

The size and age structure of sturgeon populations must be considered in conjunction with numerical abundance. Historically populations of long-lived fish such as sturgeon held some old and very large individuals. Human interference has reduced the average age of the populations. Indian Point will contribute to this reduction as impingement losses effectively reduce the likelihood that an individual will reach old age.

While in-combination effect arguments are recognised, the lack of information on the range of mortality rates attributable to man and their combined impact on the Hudson population is unclear.

Atlantic Sturgeon

Recent spawning is only known from the Hudson and Delaware rivers; therefore, the fate of Atlantic sturgeon in the Hudson is of considerable importance.

The present information available on Atlantic sturgeon impingement and juvenile abundance is poor as it comes from pre-1991 studies. It is estimated that impingement will kill a small proportion of the juvenile population and, therefore, will not likely jeopardise the continued existence of the Atlantic Sturgeon. However, we seek a recovery of this species to levels where the population is sustainable and able to take the inevitable setbacks. Impingement mortality and habitat degradation do not contribute to, but hinder, recovery.

There is some indication that the population is presently increasing, but this is poor and gives no grounds to claim that power plant losses are of no import.

As with the shortnose sturgeon, in-combination effects are not well quantified.

Riverkeeper Amended Contention RK-EC-8A:

Attachment 9

New York State Department of Environmental Conservation
Assistant Commissioner
Office of Natural Resources, 14th Floor
625 Broadway, Albany, New York 12233-1010
Phone: (518) 402-8533 ◦ **Fax:** (518) 402-9016
Website: www.dec.ny.gov

Joe Martens
Commissioner

March 25, 2013

Dr. Amy Hull, Branch Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Program
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: NMFS's January 30, 2013 Biological Opinion for Continued Operation of Indian Point Nuclear Generating Unit Nos. 2 and 3

Dear Dr. Hull:

On January 30, 2013, the National Marine Fisheries Service (NMFS) provided the Nuclear Regulatory Commission (NRC) with a written Biological Opinion (BiOp) and Incidental Take Statement (ITS) for the continued operation of Indian Point Nuclear Generating Station Units 2 and 3 (IP2 and IP3) "pursuant to existing operating licenses and proposed renewed operating licenses to be issued to Entergy Nuclear Operations, Inc. (Entergy)" after consultation under Section 7 of the federal Endangered Species Act (ESA). While the letter accompanying the January 30, 2013 BiOP and ITS stated that NMFS had "concerns regarding the *significant uncertainty* regarding the proposed action" (*i.e.*, citing New York's draft SPDES permit and 2010 denial of Entergy's CWA §401 Water Quality Certificate for IP2 and IP3), NMFS nevertheless exempted the mortality of two different endangered fish species from the date the BiOp and ITS was issued until 2035.

As the agency responsible for administering provisions of the ESA in New York pursuant to an agreement with NMFS under Section 6(c)(1) of the ESA, the Department of Environmental Conservation (DEC) submits its concerns and hereby requests that the January 30, 2013 BiOp and ITS for IP2 and IP3 be rescinded, reconsidered, and modified for the following reasons:

(1) The continued operation of IP2 and IP3 in once-through cooling mode for an additional 20 years does not meet New York State's water quality regulations (Title 6 of NYCRR, Chapter X, Parts 701-704);
(2) NMFS did not consult with DEC prior to issuing the January 30, 2013 BiOp and ITS even though NMFS recognized DEC's regulatory authority over the cooling water intake structures (CWISs) for IP2 and IP3;
(3) NMFS's exemption from Section 9 of the ESA for the total "take" of 564 shortnose sturgeon and 416 Atlantic sturgeon from future operations at Indian Point[1] was largely inflated by an unsupported assumption;
(4) NMFS previously determined that the continued operation of Indian Point's once-through cooling water system would have significant impacts on

[1] These totals consist of the "take" of sturgeon by Indian Point Units 1, 2, and 3.

Essential Fish Habitat and recommended that NRC require closed-cycle cooling at IP2 and IP3 for future operations;

(5) NMFS's January 30, 2013 BiOp and ITS neither required nor recommended that any effort be made to reduce the amount of fish mortality at IP2 and IP3 by the impingement of endangered sturgeon species but merely exempted the mortality as if this was an unavoidable loss; and

(6) The "take" of 416 New York Bight Distinct Population Segment (NYS-DPS) Atlantic sturgeon was exempted even though NMFS lacked both empirical abundance estimates of the number of fish comprising the NYS-DPS and current sturgeon impingement data from IP2 and IP3.

I. The continued operation of IP2 and IP3 in once-through cooling mode for an additional 20 years does not meet New York State's water quality regulations (Title 6 of NYCRR, Chapter X, Parts 701-704).

On April 6, 2009, DEC received a Joint Application for a federal Clean Water Act (CWA) §401 Water Quality Certificate (WQC) on behalf of Entergy Indian Point Unit 2 LLC, Entergy Indian Point Unit 3, LLC, and Entergy Nuclear Northeast (collectively IP2 and IP3). This application was submitted to DEC as part of Entergy's request to renew the NRC operating licenses for IP2 and IP3 for an additional 20 year period. In accordance with CWA §401, DEC was required to determine whether to issue a certificate verifying that an activity which may result in a discharge into navigable waters – such as operation of IP2 and IP3 – meets State water quality standards *before* a federal license or permit for such activity can be issued.

As NMFS accurately reported on page 13 of its January 30, 2013 BiOp and ITS, DEC determined in 2010 that the Indian Point "facilities, whether operated as they are currently or operated with the addition of a cylindrical wedge-wire screen system . . . do not and will not comply with existing New York State water quality standards" (at p. 1). *See also* DEC's April 2, 2010 Notice of Denial of Entergy's §401 WQC, at pp. 1-2. In the letter accompanying NMFS's January 30, 2013 2013 BiOp and ITS, Regional Administrator Bullard noted that New York's denial of a CWA §401 WQC to IP2 and IP3 raised "significant uncertainty regarding the proposed action." Mr. Bullard's letter also made clear that NMFS issues incidental take statements *only* for "[o]therwise lawful activities . . . that meet *all* State and Federal legal requirements, including any state endangered species laws or regulations" (at p. 2). Because DEC determined in 2010 that the proposed action subject to NMFS review, namely the proposed federal re-licensing of IP2 and IP3 for an additional 20 years, did not meet New York State water quality requirements, NMFS had no option but to deny any incidental take of shortnose and Atlantic surgeon by the facilities (*see* ESA Sec. 10[a][1][B]).

Whether DEC's 2010 denial of Entergy's §401 WQC is the subject of a challenge by Entergy is not relevant to the inquiry by NMFS. DEC's April 2, 2010 §401 WQC denial was clear and unequivocal that the very action for which NMFS issued the January 2013 BiOp and ITS – continued use of once-through cooling – does not now, and will not in the future, meet New York State water quality standards.

II. NMFS did not consult with DEC prior to issuing the January 30, 2013 BiOp and ITS even though NMFS recognized DEC's regulatory authority over the cooling water

intake structures (CWISs) for IP2 and IP3.

Pursuant to the ESA, NMFS is required to "insure that any action authorized, funded, or carried out . . . is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, *after consultation as appropriate with affected States*" (ESA §7[a][2]) (emphasis added). NMFS's recent issuance of a BiOp and ITS for IP2 and IP3 breached the letter and spirit of Section 7 because it was done without any consultation with DEC. Furthermore, NMFS's action breached a longstanding cooperative agreement between NMFS and DEC for the conservation of threatened and endangered species (*see* "Full Cooperation Agreement" between NMFS and DEC, originally entered in 1992).

In pages 9 through 13 of the January 30, 2013 BiOp and ITS, NMFS reviewed the regulatory authority that DEC has over the operations of IP2 and IP3, including the cooling water intake structures (CWISs) for the facilities. NMFS accurately recounts that, since 1975, DEC has been responsible for implementing sections 316(a) and 316(b) of the CWA. Indeed, NMFS stated that DEC "has the authority, under the CWA and state law, to issue SPDES permits for the withdrawal of cooling water for operations at the Indian Point facilities and for the resulting discharge of waste heat and other pollutants into the Hudson River" (*see* BiOp and ITS, at p. 10)

Not only did NMFS fail to appropriately consult with DEC prior to issuing the 2013 BiOp and ITS, NMFS also included a requirement for impingement monitoring studies to be conducted at Indian Point. This requirements directs the NRC and Entergy to provide impingement study plans to NMFS within 60 days of the final BiOp and ITS (approximately by April 1, 2013). NMFS will then review, edit, and finalize the monitoring study plan. If the NRC and Entergy believe that State approval is also required, DEC will be given an opportunity to review the plan *after* the NRC and NMFS have already agreed on the content (*see* BiOp and ITS, at pp. 133-134). These "non-discretionary" studies could require modifications to the CWISs for IP2 and IP3 – currently regulated by DEC – and have the potential to affect the survival of other species impinged on the intake screens of those Units. Under the CWA and recognized State law, DEC *must* approve any impingement study plans proposed for or conducted on Indian Point's CWISs, and DEC must be consulted prior to any approvals of proposed studies.

III. NMFS's exemption from Section 9 of the ESA for the total "take" of 564 shortnose sturgeon and 416 Atlantic sturgeon from future operations at Indian Point was largely inflated by an unsupported assumption.

The final estimated incidental take of both endangered species by NMFS included a correction factor of "1.6 to account for increased water usage." However, established science does not support the application of a water use correction factor. In developing the BiOp and ITS, NMFS analyzed both water use and impingement data for Indian Point from the 1980s and did not find any such relationship (*see* BiOp and ITS, at pp. 74 and 82). The Electric Power Research Institute (EPRI 2003) also did not find a clear relationship between the number of fish impinged and the volume of water withdrawn after reviewing impingement data collected at industrial facilities across the United States. EPRI concluded that while this relationship might be conceptually clear, it was not evident through data analyses. DEC found similar results when it compared impingement with CWIS capacity usage at industrial facilities in New York (*see* Nieder 2010). While the effect of using a correction factor had on NMFS's final exempted take estimate is not known, it was not appropriate for NMFS to apply a correction which resulted in a greater number of sturgeon to be taken rather than protected.

IV. NMFS previously determined that the continued operation of Indian Point's once-through cooling water system would have significant impacts on Essential Fish Habitat and recommended that NRC require closed-cycle cooling at IP2 and IP3 for future operations.

In October 2010, NMFS completed an Essential Fish Habitat consultation with NRC for the assessment provided in the Generic Environmental Impact Statement (dGEIS) and appendices for NRC's renewal of operating licenses for IP2 and IP3 (*see* October 12, 2010 letter from NMFS Asst. Regional Administrator Peter D. Colosi, Jr. to Messrs. Brian E. Holian and David J. Wrona at NRC). Similar to the requirement for consultation under the ESA, an EFH assessment requires NMFS to recommend alternatives to the proposed action that will minimize impacts to the resources being protected by the EFH designation (50 CFR 600.920[e][3][iv]). NMFS identified eight different EFH species in the Hudson River by IP2 and IP3: Atlantic sea herring, Bluefish, Atlantic butterfish, Red hake, Black sea bass, Summer flounder, Winter flounder, and Windowpane flounder.

> "Extrapolating from the dGEIS, *NMFS notes that the primary impacts of concern regarding fishery resources and their habitat generally, and for EFH in particular, that would be associated with continued operations using an open-ended cooling system would be organism loss and habitat degradation*. We could not enumerate these impacts based upon the materials provided for our review, but note that at over 2 billion gallons of water consumed per day, the amount of prey available to fishes in particular would be significantly diminished through entrainment alone."

Oct. 12, 2010 Colosi letter to NRC, at p. 8 *(emphasis added)*.

As a result of its EFH consultation, NMFS determined in 2010 that the continued use of a once-through cooling system at Indian Point for an additional 20 years would result in significant impact to the designated EFH of the Hudson River estuary. "NMFS agrees with New York that a closed-cycle cooling system would . . . reduce impacts associated with . . . impingement and entrainment" and recommended that NRC require closed-cycle cooling for the duration of the license renewal as a conservation measure to minimize the impacts of future operations of IP2 and IP3 upon EFH (*see* Oct. 12, 2010 Colosi letter, at pp. 5, 6, and 9). Because Entergy has not proposed to retrofit IP2 and IP3 with a closed-cycle cooling system as part of its NRC renewal, there is no reason to believe that the impacts to NMFS-designated EFH species or habitat would be reduced during the 20-year renewal period.

V. NMFS's January 30, 2013 BiOp and ITS neither required nor recommended that any effort be made to reduce the amount of fish mortality at IP2 and IP3 by the impingement of endangered sturgeon species but merely exempted the mortality as if this was an unavoidable loss.

Section 7 of the ESA requires that NMFS "specifies those reasonable and prudent measures that the Secretary considers necessary or appropriate to minimize such impact" (*see*

ESA Section 7[b][4][C][ii]). In the January 30, 2013 BiOp and ITS, NMFS found that the continued use of a once-through cooling system at IP2 and IP3 for an additional 20 years was likely to adversely affect the continued existence of shortnose sturgeon and the NYB-DPS of Atlantic sturgeon. Furthermore, NMFS identified the primary cause of take to be the impingement mortality of both sturgeon species on either the bar racks or traveling screens of the CWISs for Units 1, 2 and 3. However, nowhere in the recent BiOp and ITS did NMFS require any action be taken to actually minimize such impact from continued operation of the facilities. Indeed, the reasonable and prudent measures, as well as the terms and conditions to implement such measures, established by NMFS in its BiOp and ITS consist only of monitoring "the intakes to document the amount of incidental take . . . and to examine the shortnose and Atlantic sturgeon that are impinged at the facility" (*see* BiOp and ITS, at p. 132).

The absence of any requirement in the BiOp and ITS for IP2 and IP3 to genuinely reduce or minimize incidental take of sturgeon from the continued operation of the facilities was surprising given the fact that NMFS had previously determined in its 2010 EFH Consultation that a closed-cycle cooling system was an appropriate, available technology to reduce impingement of all fish species at IP2 and IP3.

VI. The "take" of 416 NYS-DPS Atlantic sturgeon was exempted even though NMFS lacked both empirical abundance estimates of the number of fish comprising the NYS-DPS and current sturgeon impingement data from IP2 and IP3.

NMFS determined that the NYB-DPS of Atlantic sturgeon, the majority of which spawns in the Hudson River *"is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect population recovery"* (*see* BiOp and ITS, at pp. 36-37).

NMFS identified many stressors that continue to kill or injure sturgeon (*e.g.*, commercial fishing by-catch, dredging, vessel strikes, water quality and contaminants) but concluded without any ". . . empirical estimates of the number of Atlantic sturgeon in the New York Bight DPS..." that the death of 416 Atlantic sturgeon by impingement on Indian Point's CWISs would nevertheless have little to no effect on the recovery of this federally listed endangered species (*see* BiOp and ITS, at p. 36). It is well known in the scientific community that these stressors do not work in isolation to cause mortality but add cumulatively to the overall impact upon species. Since NMFS did not have any empirical estimates of the number of Atlantic sturgeon in the NYB-DPS, it is far from clear how NMFS determined that the unnatural mortality of 416 Atlantic sturgeon, in addition to all the other stressors NMFS identified, would not, in a cumulative manner, jeopardize the recovery of this endangered species.

Furthermore, NMFS did not possess any recent or current data on the number of either species of sturgeon impinged at IP2 and IP3 when it rendered the BiOp and ITS. The data provided to NMFS for the purpose of preparing its BiOp and ITS, and to determine the manner and number of sturgeon "taken" by the facilities, were decades old and there was no assurance that the modeling undertaken by NMFS, Entergy, or the NRC accurately predicted the number of sturgeon which would be impinged at the facilities over the next 20 years.

In sum, either the NYB-DPS of Atlantic sturgeon is at risk of extinction or it is not. If the species is at risk, then it is neither prudent nor responsible for NMFS to determine a level of incidental take based on both a lack of population data and decades old impingement data from the facilities subject to re-licensing.

Conclusion

NMFS's January 30, 2013 BiOp and ITS issued to NRC for IP2 and IP3 must be remanded to NMFS for further analysis and evaluation because it was issued for an activity that was already determined to violate New York State water quality requirements, was issued in the absence of any consultation with DEC, and was based upon inappropriate data necessary to make a reasonably accurate estimate of both the level of incidental take (for either sturgeon species) and the impact the exempted take may have on the recovery of the NYB-DPS of Atlantic sturgeon. We look forward to being actively involved in the process going forward. Thank you.

Sincerely,

Kathleen Moser

Kathleen M. Moser
Assistant Commissioner
Natural Resources

c: National Marine Fisheries Service
Northeast Region
55 Great Republic Drive
Gloucester, Massachusetts 01930-2276
Attn: John K. Bullard, Regional Administrator

EDMS#465274v1