Stuyvenberg, Andrew

From: Logan, Dennis
Sent: Friday, August 26, 2011 4:01 PM
To: Gray, Dara F
Cc: IPRenewal NPEmails; Stuyvenberg, Andrew; Bauer, Laurel
Subject: FW: Indian Point Draft Biological Opinion
Attachments: Transmittal Memo for Draft BiOp to NRC for Indian Point Power Plant relicensing.pdf; Katherine_StCyr.vcf

Dara,

I am forwarding to you the draft biological opinion for Indian Point that we just received from NOAA.

Dennis

-----Original Message-----
From: Katherine St. Cyr [mailto:Katherine.StCyr@noaa.gov]
Sent: Friday, August 26, 2011 3:41 PM
To: Stuyvenberg, Andrew; Logan, Dennis; Mary A. Colligan; Julie.Williams@noaa.gov
Cc: Julie Crocker
Subject: Indian Point Draft Biological Opinion

Please see the attached (sending for Julie Crocker).

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

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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.

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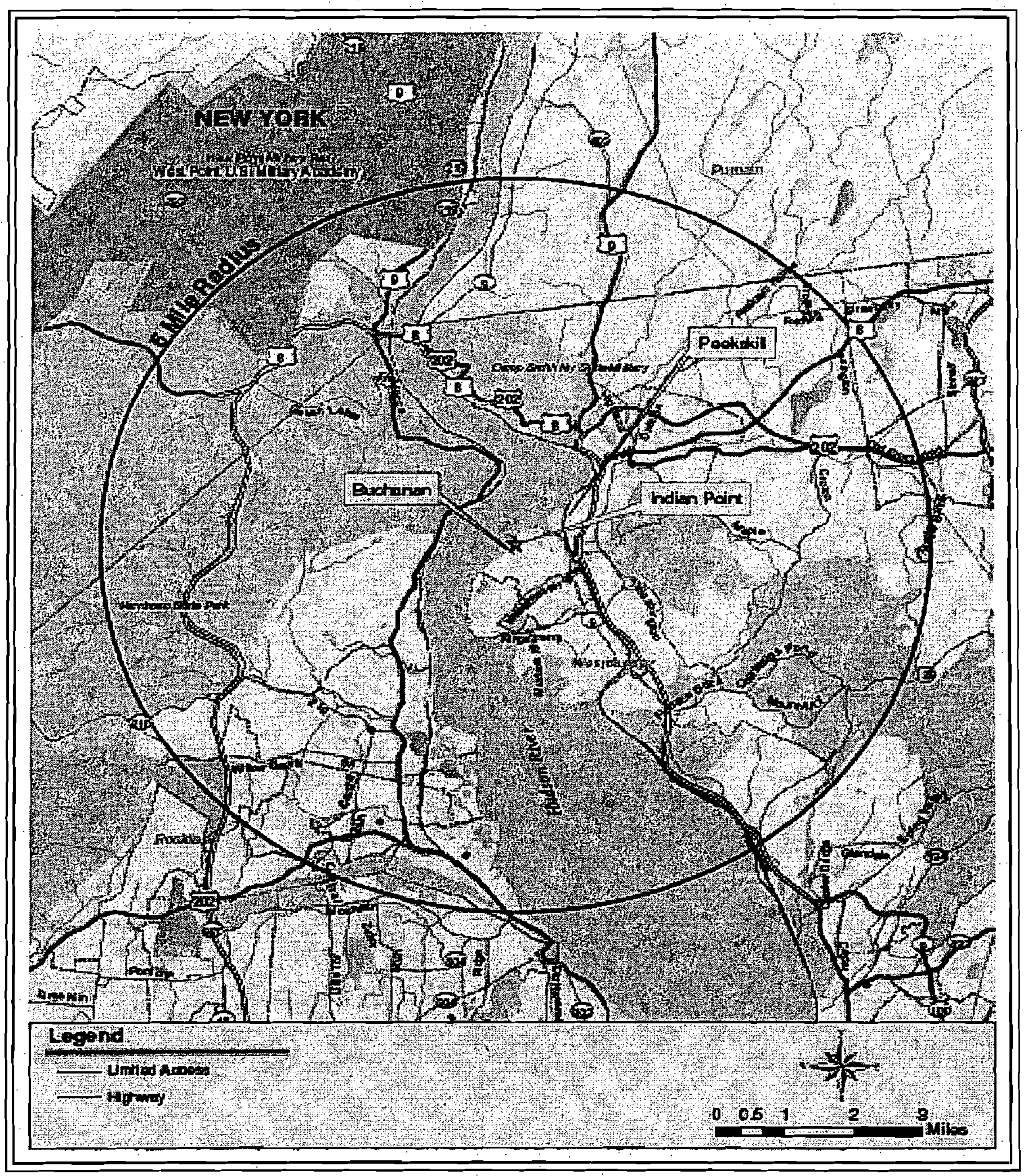
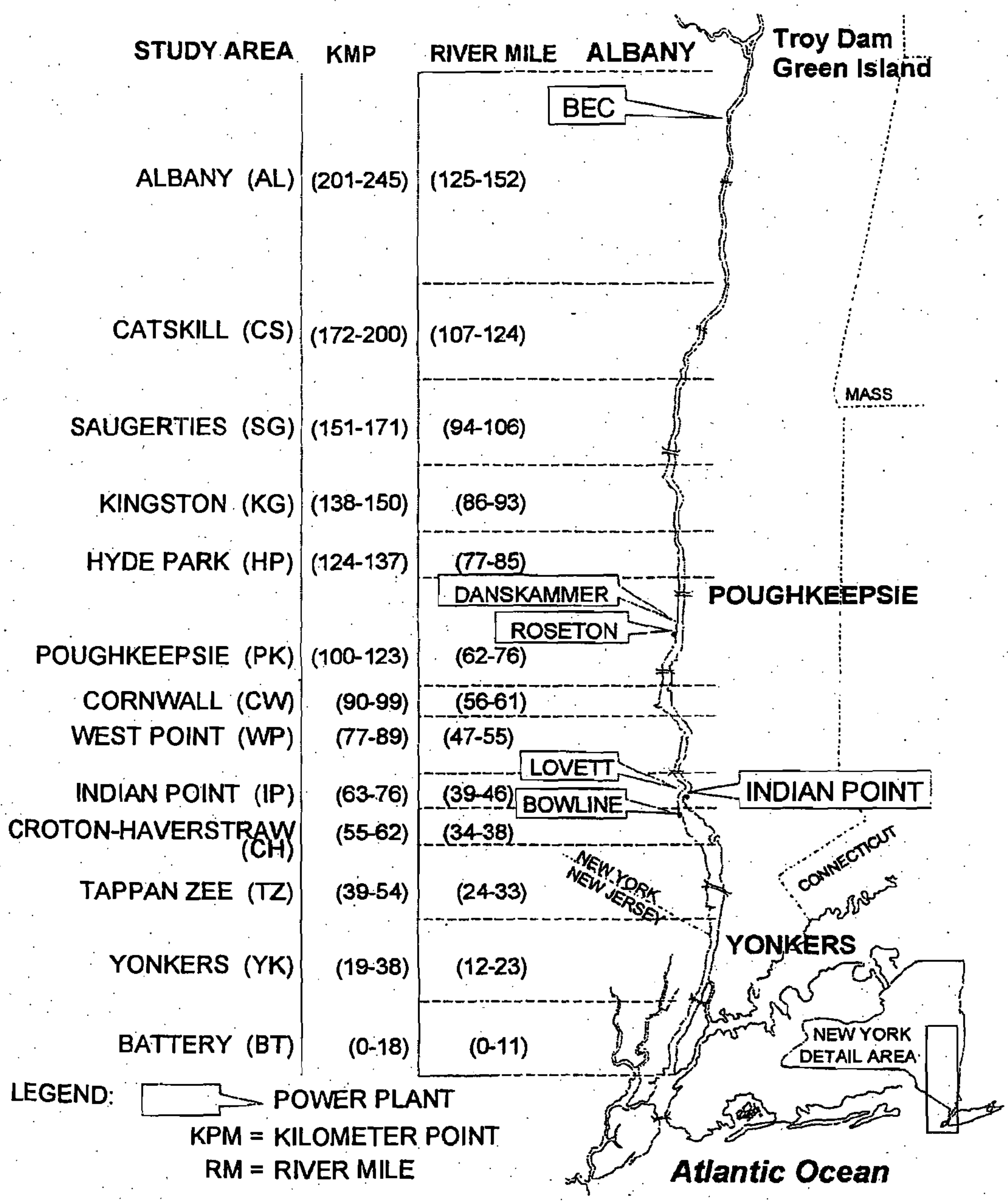


Source: Entergy 2007a

Figure [illegible]. 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 ____________________

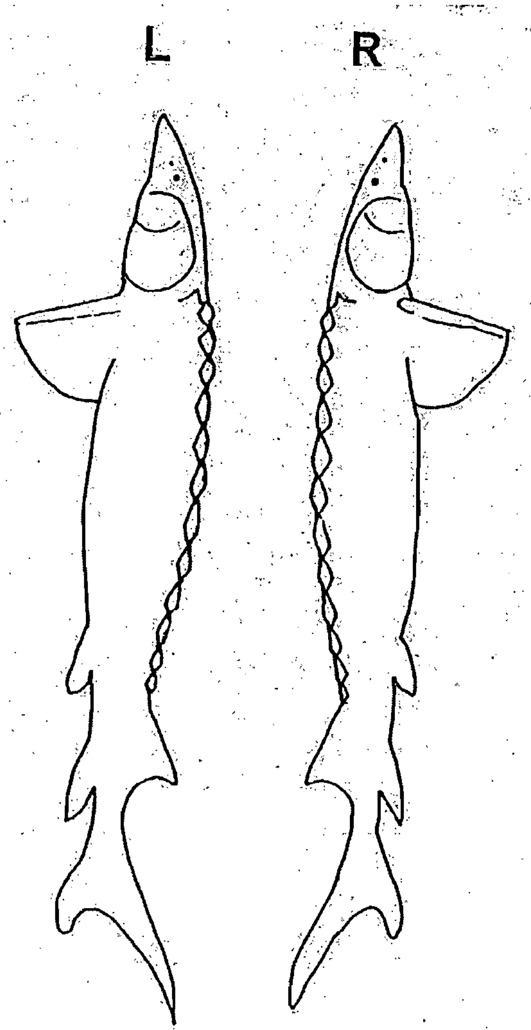
Condition of specimen/description of animal
____
____
____
____

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

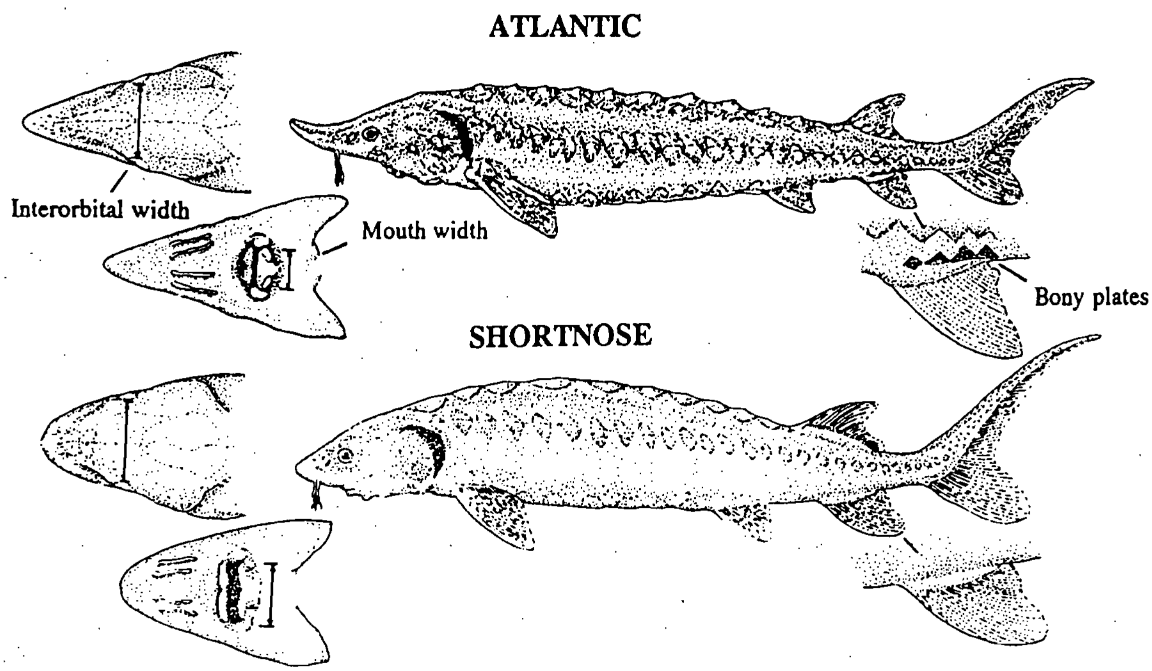
Draw wounds, abnormalities, tag locations on diagram and briefly describe below



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.

Stuyvenberg, Andrew

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