ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Agency: Nuclear Regulatory Commission

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

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

Date Issued: OCT 14 2011

Approved by: for PATRICIA KURKUL

INTRODUCTION

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

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

BACKGROUND AND CONSULTATION HISTORY

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

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IP1 is usedfor service water for IP2; however, IP1 no longer is used for generating electricity and no cooling water is withdrawn from the IP1 intake.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

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

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

Endangered Species Act Consultation

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

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

In this testimony, Dr. Dadswell provides information on the life history of shortnose sturgeon and summarizes what was known at the time about the population in the Hudson River. Dr. Dadswell indicates that at the time it was estimated that there were approximately 6,000 adult and sub-adult shortnose sturgeon in the Hudson River population (Dadswell 1979) and that the population had been stable at this number between the 1930s and 1970s. Dr. Dadswell determined that there is no known entrainment of shortnose sturgeon at these facilities and little, if any, could be anticipated. Based on available information regarding impingement at IP2 and IP3, Dadswell estimated a worst case scenario of 35 shortnose sturgeon impingements per year,

including 21 mortalities (assuming 60% impingement mortality). Dadswell estimated that this resulted in a loss of 0.3-0.4% of the shortnose sturgeon population in the Hudson each year and that this additional source of mortality will not "appreciably reduce the likelihood of the survival and recovery of the shortnose sturgeon." In conclusion Dadswell stated that the once through cooling systems being considered in the case were "not likely to jeopardize the continued existence of the shortnose sturgeon because, even assuming 100% mortality of impinged fish, its contribution to the natural annual mortality is negligible." Dr. Dadswell did also note that as there is no positive benefit to impingement, any reductions in the level of impingement would aid in the conservation of the species. No additional ESA consultation has occurred between NRC and NMFS on the operation of IP2 and IP3 and the effects on shortnose sturgeon; incidental take associated with IP2 or IP3 has never been exempted.

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

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

DESCRIPTION OF THE PROPOSED ACTION

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

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

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

Neither IP2 or IP3 can operate without cooling water, and NRC is responsible for authorizing the operation of nuclear facilities, as well as approving any extension of an initial operating license through the license renewal process. Intake and discharge of water through the cooling water system would not occur but for the operation of the facility pursuant to a renewed license; therefore, the effects of the cooling water system on shortnose sturgeon are a direct effect of the proposed action. NRC staff state that the authority to regulate cooling water intakes and discharges under the CWA lies with EPA, or in this case, NYDEC, as the state has been delegated NPDES authority by EPA. Pursuant to NRC's regulations, operating licenses are conditioned upon compliance with all applicable law, including but not limited to CWA Section 401 Certifications and NPDES/SPDES permits. Therefore, the effects of the proposed Federal action-- the continued operation of IP2 and IP3 as proposed to be approved by NRC, which necessarily involves the removal and discharge of water from the Hudson River-- are shaped not

only by the terms of the renewed operating license but also by the NYDEC 401 Water Quality Certification and any conditions it may contain that would be incorporated into its SPDES permits. This Opinion will consider the effects of the operation of IP2 and IP3 pursuant to the extended Operating License to be issued by the NRC and the SPDES permits issued by NYDEC that are already in effect. NRC requested consultation on the operation of the facilities under the existing NRC license terms and the existing SPDES permits, even though a new SPDES permit might be issued in the future. A complete history of NYDEC permits is included in NRC's FSEIS at Section 2.2.5.3 (Regulatory Framework and Monitoring Programs) and is summarized below.

NPDES/SPDES Permits

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

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

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

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

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

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

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

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

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

In November 2003, NYDEC issued a draft SPDES permit for IP2 and IP3 that required Entergy, among other things, to retrofit the Indian Point facilities with closed-cycle cooling or an equivalent technology in order to minimize the adverse environmental impact caused by the CWISs in accordance with 6 NYCRR § 704.5 and CWA § 316(b). The draft permit contains conditions which address three aspects of operations at Indian Point: conventional industrial-wastewater pollutant discharges, thermal discharge, and cooling water intake. Limits on the conventional industrial discharges are not proposed to be changed significantly from the previous permit. The draft permit does, however, contain new conditions addressing the thermal discharge and additional new conditions to implement the measures NYDEC has determined to be the best technology available for minimizing impacts to aquatic resources from the cooling water intake, including the installation of a closed cycle cooling system at IP2 and IP3. With respect to thermal discharges, the draft SPDES permit would require Entergy to conduct a tri-axial (three-dimensional) thermal study to document whether the thermal discharges from IP2 and IP3 comply with state water quality criteria. The draft permit states that if IP2 and IP3 do not meet state standards, Entergy may apply for a modification of those criteria in an effort to demonstrate to NYDEC that such criteria are unnecessarily restrictive and that the requested modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish and wildlife in the Hudson River, which is an applicable CWA water quality-related standard. The draft permit also states that Entergy may propose, within a year of the permit's becoming effective, an alternative technology or technologies that can minimize adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3. In order to implement closed-cycle cooling, the draft permit would require Entergy to submit a pre-design engineering report within one year of the permit's

effective date. Within one year after the submission of the report, Entergy must submit complete design plans that address all construction issues for conversion to closed-cycle cooling. In addition, the draft permit requires Entergy to obtain approvals for the system's construction from other government agencies, including modification of the operating licenses for IP2 and IP3 from the NRC. While steps are being taken to implement BTA, Entergy would be required to schedule and take annual generation outages of no fewer than 42 unit-days during the peak entrainment season among other measures. In 2004, Entergy requested an adjudicatory hearing with NYDEC on the draft SPDES permit. That SPDES permit adjudicatory process is presently ongoing, and its outcome is uncertain at this time.

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

401 Water Quality Certificate

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

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

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

Description of Water Withdrawals

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

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

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

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

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

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

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

The discharged cooling water is at an elevated temperature, and therefore, some water is lost because of evaporation. Based on conservative estimates, NRC estimates that this induced evaporation resulting from the elevated discharge temperature would be less than 60 cfs (27,000 gpm or 1.7 m^3/s). This loss is about 0.5 percent of the annual average downstream flow of the Hudson River, which is more than 9000 cfs (4 million gpm or 255 m^3/s). The average cooling

water transient time ranges from 5.6 minutes for the IP3 cooling water system to 9.7 minutes for the IP2 system. Auxiliary water systems for service water are also provided from the Hudson River via the dedicated bays in the IP2 and IP3 intake structures. The primary role of service water is to cool components (e.g., pumps) that generate heat during operation. Secondary functions of the service water include the following:

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

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

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

Action Area

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

LISTED SPECIES IN THE ACTION AREA

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

COMBINED STATUS OF THE SPECIES/ENVIRONMENTAL BASELINE

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

Shortnose sturgeon life history

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

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

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

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

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

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

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

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 15º (46.4-59°F), and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell et al. 1984; Hall et al. 1991, Kieffer and Kynard 1996,

NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° (46.4°F) and 12°C (53.6°F), eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

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

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

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

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

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

Status and Trends of Shortnose Sturgeon Rangewide

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

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

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

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

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

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

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

Wirgin et al. (2005) also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware,

Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

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

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

Threats to shortnose sturgeon recovery rangewide

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake

screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

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

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

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane),

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

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

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

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

dissolved oxygen may be lethal.

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

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

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

Status of Shortnose Sturgeon in the Hudson River and Environmental Baseline

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

Shortnose sturgeon were first observed in the Hudson River by early settlers who captured them

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Hudson River Power Plants

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

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

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

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

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

Scientific Studies

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

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

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

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

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

Impacts of Contaminants and Water Quality

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

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

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

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

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

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

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

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

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

Global climate change

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

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

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

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

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

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

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will

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

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

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

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

increase in precipitation of about 5% is expected; however, information on the effects of an increase in precipitation on conditions in the action area is not available.

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

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

Environmental Baseline

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

As described above, the action area is limited to the area where direct and indirect effects of the Indian Point facility are experienced and by definition is limited in the Hudson River to the

intake areas of IP1 (for service water), IP2 and IP3 and the region where the thermal plume extends into the Hudson River from IP2 and IP3. The discussion below focuses on effects of state, federal or private actions, other than the action under consideration, that occur in the action area.

Federal Actions that have Undergone Formal or Early Section 7 Consultation

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

Impacts of the Historical Operation of the Indian Point Facility

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

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

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

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

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

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

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

EFFECTS OF THE ACTION

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

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

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

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

Effects of Water Withdrawal

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

Entrainment of Shortnose sturgeon

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects organisms with limited swimming ability that can pass through the screen mesh, used on the intake systems. Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and

then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000 in NRC 2011). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

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

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

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

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

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

Impingement of Shortnose Sturgeon

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

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

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

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

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

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

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

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

Before installation of modified Ristroph screen systems in 1991, impingement mortality at IP2 and IP3 was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species. The final design of the screens, as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at IP2 and IP3. The Fletcher study reported mortality following an 8-hour holding period in an attempt to account for delayed mortality that may result from injuries

suffered during impingement. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad, with mortality rates ranging from 9-62%, depending on species. No evaluation of survival of shortnose sturgeon on the modified Ristroph screens at IP2 or IP3 was made and no monitoring has occurred since the screens were installed in 1991.

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

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

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

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

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

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

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

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

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

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

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

Effects of Impingement and Entrainment on Shortnose sturgeon prey

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

Summary of Effects of Water Withdrawal

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

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

Effects of Discharges to the Hudson River

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

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

Heated Effluent

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

(5) Estuaries or portions of estuaries.

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

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

iii. From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than an 83°F

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

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

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

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

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

Characteristics of Indian Point's Thermal Plume

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

The former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September. These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to

evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

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

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

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

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

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

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

A temperature contour plot of a cross-river transect at Indian Point prepared in response to a NYSDEC review illustrates a similar condition on July 11, 2010 during slack before flood tide (Swanson et al. 2011a, Figure 1-10). Here the thermal plume is evident to about 2000 ft (600 m) from the eastern shore (the location of the Indian Point discharge) and extends to a depth of about 35 ft (11 m) along the eastern shore. Bottom temperatures above 82°F (28°C), were confined to about the first 250 ft (76 m) from shore. The river here is over 4500 ft (1400 m) wide. In that

small area, bottom water temperatures might also exceed 30°C (86°F); elsewhere, bottom water temperatures were about 80°F (27°C). These conditions would not last long, however, as they would change with the tidal cycle. Further, any sturgeon in this location would be able to retreat to adjacent deeper and cooler water. Under no conditions did interpolated temperatures in Entergy's modeled results exceed the 28°C in the deep reaches of the river channel (Swanson 2011 a).

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

Thermal Tolerances – Shortnose sturgeon

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

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F)(Dadswell et al. 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). Foraging is known to occur at temperatures greater than 7°C (44.6°F) (Dadswell 1979). In the Altamaha River, temperatures of 28-30ºC (82.4-86°F) during summer months are correlated with movements to deep cool water refuges. Ziegeweid et al. (2008a) conducted studies to determine critical and lethal thermal maxima for young-of-the-year (YOY) shortnose sturgeon acclimated to temperatures of 19.5 and 24.1°C (67.1 – 75.4°F). Lethal thermal maxima were 34.8°C (±0.1) and 36.1°C (±0.1) (94.6°F and 97°F) for fish acclimated to 19.5 and 24.1°C (67.1°F and 75.4°F), respectively. The study also used thermal maximum data to estimate upper limits of safe temperature, final thermal preferences, and optimum growth temperatures for YOY shortnose sturgeon. Visual observations suggest that fish exhibited similar behaviors with increasing temperature regardless of acclimation temperature. As temperatures increased, fish activity appeared to increase; approximately 5–6°C (9-11°F) prior to the lethal endpoint, fish began frantically swimming around the tank, presumably looking for an escape route. As fish began to lose equilibrium, their activity level decreased dramatically, and at about 0.3°C (0.54°F)before the lethal endpoint, most fish were completely incapacitated. Estimated upper limits of safe temperature (ULST) ranged from 28.7 to 31.1°C (83.7-88°F)and varied with acclimation temperature and measured endpoint. Upper limits of safe temperature (ULST) were determined by subtracting a safety factor of 5°C (9°F) from the lethal and critical thermal maxima data. Final thermal preference and thermal growth optima were nearly identical for fish at each acclimation temperature and ranged from 26.2 to 28.3°C (79.16-82.9°F). Critical thermal maxima (the point at which fish lost equilibrium) ranged from 33.7 (±0.3) to 36.1°C (±0.2) (92.7-97°F) and varied with acclimation temperature. Ziegeweid et al. (2008b) used data from

laboratory experiments to examine the individual and interactive effects of salinity, temperature, and fish weight on the survival of young-of-year shortnose sturgeon. Survival in freshwater declined as temperature increased, but temperature tolerance increased with body size. The authors conclude that temperatures above 29°C (84.2°F) substantially reduce the probability of survival for young-of-year shortnose sturgeon. However, previous studies indicate that juvenile sturgeons achieve optimum growth at temperatures close to their upper thermal survival limits (Mayfield and Cech 2004; Allen et al. 2006; Ziegeweid et al. 2008a), suggesting that shortnose sturgeon may seek out a narrow temperature window to maximize somatic growth without substantially increasing maintenance metabolism. Ziegeweid (2006) examined thermal tolerances of young of the year shortnose sturgeon in the lab. The lowest temperatures at which mortality occurred ranged from 30.1 – 31.5°C (86.2-88.7°F) depending on fish size and test conditions. For shortnose sturgeon, dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Effect of Thermal Discharge on Shortnose Sturgeon

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

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

sturgeon spend near the surface, the small area where such high temperatures will be experienced and the gradient of warm temperatures extending from the outfall; shortnose sturgeon are likely to begin avoiding areas with temperatures greater than 28°C (82.4°F) and are unlikely to remain within the heated surface waters to swim towards the outfall and be exposed to temperatures which could result in mortality. Below, NMFS considers what effect this avoidance behavior would have on individual shortnose sturgeon. Near the bottom where shortnose sturgeon most often occur, water temperatures are not likely to ever reach 33.7°C (92.7°F), creating no risk of exposure to temperatures likely to be lethal near the bottom of the river.

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

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

Under no conditions did interpolated temperatures in Entergy's modeled results exceed 28°C (82°F) in the deep reaches of the river channel (Swanson 2011 a) where shortnose sturgeon are most likely to occur. Swanson also examined other sources of available bottom water temperature data for the Indian Point area. Based upon examination of the 1997 through 2010 long river survey water temperature data from the near-bottom stations near Indian Point, 28°C (82.4°F) was exceeded for just 56 of 1,877 observations or 2.98% during this 14-year period

(readings measured weekly from March through November). These already low incidences of observed near-bottom water temperatures above 28°C (82.4°F) would be even lower when viewed in the context of an entire year instead of the nine months sampled due to the cold water period not sampled from December through February (i.e., 2.24% for the Indian Point region).

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

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

Effect on Shortnose Sturgeon Prey

Shortnose sturgeon feed primarily on benthic invertebrates; these prey species are found on the bottom. As explained above, the IP thermal plume is largely a surface plume with elevated temperatures near the bottom limited to short duration and a geographic area limited to the area close to the discharge point. No analysis specific to effects of the thermal plume on the macroinvertebrate community has been conducted. However, given what is known about the plume (i.e., that it is largely a surface plume and has limited effects on water temperatures at or

near the bottom) and the areas where shortnose sturgeon forage items are found (i.e., on the bottom), it is unlikely that potential shortnose sturgeon forage items would be exposed to the effects of the thermal plume. If the thermal plume is affecting benthic invertebrates, the most likely effect would be to limit their distribution to areas where bottom water temperatures are not affected by the thermal plume. Considering that shortnose sturgeon are also likely to be excluded from areas where the thermal plume influences bottom water temperatures and given that those areas are small, foraging shortnose sturgeon are not likely to be affected by any limits on the distribution of benthic invertebrates caused by the thermal plume's limited influence on bottom waters. Thus, based on this analysis, it appears that the prey of shortnose sturgeon, would be impacted insignificantly, if at all, by the thermal discharge from IP.

Potential Discharge of Radionuclides to the Hudson River

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

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

The REMP at IP2 and IP3 directs Entergy to sample environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The REMP designates sampling locations for the collection of environmental media for analysis. These sampling locations are divided into indicator and control locations. Indicator locations are established near the site, where the presence of radioactivity of plant origin is most likely to be detected. Control locations are established farther away (and upwind/upstream, where applicable) from the site, where the level would not generally be affected by plant discharges or effluents. The use of indicator and control locations enables the identification of potential sources of detected radioactivity as either background or from plant operations. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents. The REMP is used to measure the direct radiation and the airborne and waterborne pathway activity in the vicinity of the IP2 and IP3 site. Direct radiation pathways include radiation from buildings and plant structures, airborne material that may be released from the plant, or from cosmic radiation, fallout, and the naturally occurring radioactive materials in soil, air, and water. The liquid waste processing system at IP2 and IP3 collects, holds, treats,

processes, and monitors all liquid radioactive wastes for reuse or disposal. During normal plant operations the system receives input from numerous sources, such as equipment drains and leak lines, chemical laboratory drains, decontamination drains, demineralizer regeneration, reactor coolant loops and reactor coolant pump secondary seals, valve and reactor vessel flange leak lines, and floor drains. After it is determined that the amount of radioactivity in the wastewater is diminished to acceptable levels, the water is released into the Hudson River.

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

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

The study concluded that there were no apparent excursions above criteria for the protection of biota based on the radionuclide data available. The levels of radionuclides, including ^{90}Sr, were two to five orders of magnitude lower than criteria established by the US Department of Energy (USDOE 2002) for the protection of aquatic animals and freshwater ecosystems. Also, the study concluded that there were no spatial differences in concentrations of ^{90}Sr and ^{224}Ra in resident

fish from the three locations sampled in the lower Hudson River (i.e., Indian Point facility, and the reference sites at the Roseton Generating Station and at Catskill). In contrast, ^{40}K levels were somewhat greater in the vicinity of Roseton Generating Station, but the differing concentrations have no known significance.

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

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

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

Other Pollutants Discharged from IP2 and IP3

The 1987 SPDES permit contains effluent limits related to an on-site sewage treatment plant, as well as cooling water discharges. The on-site sewage treatment plant is no longer operational

and sanitary waste from Indian Point is now routed to the community wastewater treatment plant. Therefore, no sanitary waste discharges at the Indian Point outfalls will occur during the extended operating period. Other than the pollutants associated with sanitary wastes, pollutants limited by the 1987 SPDES permit include: total residual chlorine (TRC), lithium hydroxide, boron, pH, total suspended solids (TSS), and, oil and grease.

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

Total Residual Chlorine

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

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

Lithium hydroxide

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

species for other fish in toxicity testing, NMFS anticipates that any effects to shortnose sturgeon from exposure to boron at concentrations authorized by the SPDES permit would be insignificant and discountable.

Boron

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

pH

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

Total Suspended Solids

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

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

under lowered light conditions, such as those in turbid waters. As such, shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass.

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

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

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

CUMULATIVE EFFECTS

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

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

the anticipated trends described in the status of the species/environmental baseline section.

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

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

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

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

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

INTEGRATION AND SYNTHESIS OF EFFECTS

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

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

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

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

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

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

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that

could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, add uncertainty to any determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is at best stable, with gains in populations such as the Hudson, Delaware and Kennebec offsetting the continued decline of southern river populations, and at worst declining.

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

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

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

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

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

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

Based on the information provided above, the death of up to 168 shortnose sturgeon over a 20-year period resulting from the proposed continued operation of IP2 and IP3 under renewed

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

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

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in a small reduction in the number of shortnose sturgeon in the Hudson River and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is likely to result in the mortality of up to 168 shortnose sturgeon; however, over the 20-year period, the loss of these individuals and what would have been their progeny is not expected to affect the persistence of the Hudson River population of shortnose sturgeon or the species as a whole. The loss of these individuals will not change the status or trend of the Hudson River population, which is stable at high numbers. As it will not affect the status or trend of this population, it will not affect the status or trend of the species as a whole. As the reduction in numbers and future reproduction is very small, this loss would not result in an appreciable reduction in the likelihood of improvement in the status of shortnose sturgeon throughout their range. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only a small percentage of the shortnose sturgeon in the Hudson River and an even smaller percentage of the species as a whole and these mortalities are not expected to result in the reduction of overall reproductive fitness for the

species as a whole. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than 168 shortnose sturgeon over the 20-year period of the proposed renewed licenses is not likely to appreciably reduce the survival and recovery of this species.

CONCLUSION

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

INCIDENTAL TAKE STATEMENT

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

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

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

Amount or Extent of Take

Pursuant to the terms of the proposed extended operating licenses, IP2 and IP3 would continue to operate for an additional 20 years. This ITS applies to the extended operating period, beginning at the date that the facility begins to operate under the terms of a new license and extending through the expiration date of that license. NRC has indicated it is unlikely that any new license would be issued prior to the expiration date of the existing licenses. As such, NMFS anticipates that this amount of take will occur at IP2, from September 28, 2013, until September 28, 2033, and IP3 from December 12, 2015, until December 12, 2035. The exemption from Section 9 prohibitions would apply only during that time period as well. The operation of IP2 and IP3 during the extended operating period will directly affect shortnose sturgeon due to impingement at intakes. These interactions constitute "capture" or "collect" in the definition of "take" and will cause injury and mortality to the affected individuals. Based on the distribution of shortnose sturgeon in the action area and information available on historic interactions between shortnose sturgeon and the IP facility, NMFS has estimated that the proposed action will result in the impingement of up to 6 shortnose sturgeon at the IP1 intake (service water), 104 shortnose sturgeon at IP2 and 58 shortnose sturgeon at IP3 during the 20-year extended operating period. All of these sturgeon are expected to die, immediately or later, as a result of interactions with the facility. As explained in the "Effects of the Action" section, effects of the facility on shortnose sturgeon also include effects on distribution due to the thermal plume as well as effects to prey items; however, NMFS does not anticipate or exempt any take of shortnose sturgeon due to effects to prey items or due to exposure to the thermal plume. This ITS exempts the following take:

- A total of 6 shortnose sturgeon (dead or alive) impinged at the Unit 1[12] intakes (trash bars or screens) during the period September 28, 2013 – September 28, 2033;
- A total of 104 shortnose sturgeon (dead or alive) impinged at Unit 2 (trash bars or Ristroph screens) during the period September 28, 2013 – September 28, 2033; and,
- A total of 58 shortnose sturgeon (dead or alive) impinged at Unit 3 (trash bars or Ristroph screens) during the period December 12, 2015 – December 12, 2035.

The Section 9 prohibitions against take apply to live individuals as well as to dead specimens and their parts. The Section 9 prohibitions include "capture" and "collect" in the definition of take, as well as injury and mortality. NMFS recognizes that shortnose sturgeon that have been killed prior to impingement at the IP facility may become impinged on the intakes at IP1, IP2 and IP3 and that some number of dead shortnose sturgeon taken at the facility may not necessarily have

12 As explained in the Opinion, water withdrawn through the Unit 1 intakes is used for service water for the operation of IP2.

been killed by the operation of the facility itself. However, the capture or collection of previously dead animals is prohibited under Section 9 and will be exempted through this ITS. Additionally, NMFS recognizes the potential for some shortnose sturgeon to pass through the trash bars, contact the Ristroph screens and travel down the sluice back to the River without significant injury or mortality. The Section 9 prohibitions on take also apply to the capture or collection of live, uninjured animals even if these animals are released without injury. Thus, it is appropriate for this ITS to also address shortnose sturgeon that may be captured or collected at the Ristroph screens and returned to the river unharmed. As no monitoring has taken place at the intakes, NMFS can not predict what percentage of shortnose sturgeon would be collected at the Ristroph screens without injury or mortality and, therefore, NMFS is not able to refine this estimate of take to separate out the number of fish that may be collected but not killed. Due to the difficulty in determining the cause of death of shortnose sturgeon found dead at the intakes and the lack of past necropsy results that would allow NMFS to better assess the likely cause of death of impinged shortnose sturgeon, the aforementioned anticipated level of take includes shortnose sturgeon that may have been dead prior to impingement on the IP intakes. As explained in the Opinion, NMFS does not have sufficient information to predict what percentage of impinged shortnose sturgeon were previously dead and merely captured or collected at the facility and sturgeon that died as a result of their impingement at the Indian Point intakes. Therefore, NMFS was not able to further refine this estimate of take into a number of previously dead sturgeon captured or collected at the facility and a number of sturgeon whose death was caused by impingement at the facility. In the accompanying Opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to shortnose sturgeon.

Reasonable and Prudent Measures

In order to effectively monitor the effects of this action, it is necessary to monitor the intakes to document the amount of incidental take (i.e., the number of shortnose sturgeon captured, collected, injured or killed) and to examine the shortnose sturgeon that are impinged at the facility. Monitoring provides information on the characteristics of the shortnose sturgeon encountered and may provide data which will help develop more effective measures to avoid future interactions with listed species. NMFS does not anticipate any additional injury or mortality to be caused by removing the fish from the water and examining them as required in the RPMs. Any live sturgeon are to be released back into the river, away from the intakes and thermal plume. These RPMs and their implementing terms and conditions apply to both the license to be issued for the continued operation of IP2 and the license to be issued for the continued operation of IP3.

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

1. A program to monitor the incidental take of shortnose sturgeon at the IP1, IP2 and IP3 intakes must be developed, approved by NMFS, and implemented throughout the duration of the extended operating period.

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

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

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

Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, Entergy must comply with, and NRC must ensure through enforceable terms of the renewed license that Entergy does comply with, the following terms and conditions of the Incidental Take Statement, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned (ESA Section 7(o)(2)). Due to the difficulty in visually distinguishing shortnose sturgeon from other sturgeon, to ensure that the incidental take level for shortnose sturgeon is not exceeded, and to guard against misidentifying and not counting fish that are in fact shortnose sturgeon, the terms and conditions below refer to "shortnose sturgeon or fish that might be shortnose sturgeon."

1. To implement RPM #1, Entergy must implement throughout the term of the renewed license an endangered species monitoring plan that has been approved by NMFS and that allows for the detection and observation of all shortnose sturgeon or fish that might be shortnose sturgeon that are impinged anywhere at the intakes, including on the trash bars, or that contact the Ristroph screens. This monitoring plan must be approved by NMFS prior to the effective date of any renewed license and must be implemented beginning on the day that the new license becomes effective. This monitoring plan must contains the following components:
    a. methods and procedure for monitoring the intake trash bars on a schedule that ensures detection and timely release of all shortnose sturgeon or fish that might be shortnose sturgeon impinged on the trash bars;
    b. any method developed to monitor the intake trash bars for shortnose sturgeon or fish that might be shortnose sturgeon must be able to detect all individuals impinged at the trash bars within 24 hours of its impingement;
    c. methods and procedures for monitoring the Ristroph screens on a schedule that ensures detection and timely release of all shortnose sturgeon or fish that might be shortnose sturgeon that pass through the trash bars and contact or are impinged on the screens;
    d. any method developed to monitor the Ristroph screens must ensure the detection and inspection of all shortnose sturgeon or fish that might be a shortnose sturgeon prior to its being discharged back into the River;

e. a handling and release plan that describes how all live shortnose sturgeon or fish that might be shortnose sturgeon that are impinged at the trash bars or the Ristroph screens will be safely removed from the water, handled for examination, and returned to the River;
f. handling and disposal procedures for dead shortnose sturgeon or body parts of shortnose sturgeon or fish that may be shortnose sturgeon;
g. procedures for obtaining genetic samples from all shortnose sturgeon or fish that may be shortnose sturgeon;
h. reporting forms that contain all information to be reported for all incidental takes of shortnose sturgeon or fish that may be shortnose sturgeon;
i. procedures for notifying NMFS of all incidental takes; and,
j. procedures for making any necessary updates or modifications to the monitoring plan.

2. To implement RPM #2, Entergy must ensure that all live shortnose sturgeon or fish that might be shortnose sturgeon are returned to the river away from the intakes and the thermal plume, following complete documentation of the event. Handling and release procedures must be a part of the monitoring plan outlined in Term and Condition #1.

3. To implement RPM #3, Entergy must ensure that all dead specimens or body parts of shortnose sturgeon or fish that might be sturgeon are photographed, measured, and preserved (refrigerate or freeze). No dead shortnose sturgeon or body parts of shortnose sturgeon or fish that might be sturgeon may be disposed without discussing disposal procedures with NMFS. General disposal procedures will be included in the monitoring plan outlined in Term and Condition #1 above. NMFS may request that the specimen be transferred to NMFS or to an appropriately permitted researcher so that a necropsy may be conducted. The form included as Appendix I must be completed and submitted to NMFS as noted above.

4. To implement RPM #4, if any live or dead shortnose sturgeon or fish that might be shortnose sturgeon are taken at IP1, IP2 or IP3, Entergy must notify NMFS (978-281-9328) and NRC immediately. An incident report (Appendix I) must also be completed by plant personnel and sent to the NMFS Section 7 Coordinator via FAX (978-281-9394) within 24 hours of the take. Every shortnose sturgeon, or fish that might be a shortnose sturgeon, must be photographed. Information in Appendix II will assist in identification of a shortnose sturgeon or fish that might be a shortnose sturgeon.

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

6. To implement RPM #4, Entergy must submit an annual report of incidental takes to NMFS and NRC by February 15 of each year. The report must include, as detailed in this Incidental Take Statement and the monitoring plan required by Term and Condition #1, any necropsy reports of specimens, incidental take reports, photographs , a record of all

sightings of shortnose sturgeon, or fish that might be a shortnose sturgeon, in the vicinity of Indian Point, and a record of when inspections of the intake trash bars and Ristroph screens were conducted for the 48 hours prior to the take. The annual report must also identify any potential measures to reduce shortnose sturgeon impingement, injury, and mortality at the intake structures. At the time the report is submitted, NMFS will supply NRC and Entergy with any information on changes to reporting requirements (i.e., staff changes, phone or fax numbers, e-mail addresses) for the coming year.

7. To implement RPM #4, Entergy must ensure that fin clips are taken (according to the procedure outlined in Appendix III and as included in the monitoring plan required by Term and Condition #1) of any shortnose sturgeon or fish that might be shortnose sturgeon, and that the fin clips are sent to NMFS for genetic analysis .

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

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

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

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

operation of the facility.

RPM#4 and Term and Condition #4-7 are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as the prompt reporting of these interactions to NMFS. Sampling of fin tissue is used for genetic sampling. This procedure does not harm shortnose sturgeon and is common practice in fisheries science. Tissue sampling does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact. NMFS has received no reports of injury or mortality to any shortnose sturgeon sampled in this way.

CONSERVATION RECOMMENDATIONS

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

1. The NRC should use its authorities to ensure tissue analysis of dead shortnose sturgeon removed from the Indian Point intakes is performed to determine contaminant loads, including radionuclides.

2. The NRC should use its authorities to ensure in-water assessments, abundance, and distribution surveys for shortnose sturgeon in the Hudson River, and Haverstraw Bay specifically, are performed.

3. The NRC should use its authorities to ensure studies are performed that document the presence, if any, of shortnose sturgeon in the broadest area affected by the thermal plume in order to validate the assumption in this Opinion that shortnose sturgeon are likely to move away from the thermal plume.

REINITIATION OF CONSULTATION

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

LITERATURE CITED

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

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

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

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

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

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

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

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

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

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

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

Buckley, J. and B. Kynard. 1985. Habitat use and behavior of pre-spawing and spawning

shortnose sturgeon, *Acipenser brevirostrum*, in the Connecticut River. North American Sturgeons: 111-117.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Kocan, R.M., M.B. Matta, and S. Salazar. 1993. A laboratory evaluation of Connecticut River

coal tar toxicity to shortnose sturgeon (*Acipenser brevirostrum)* embryos and larvae. Final Report to the National Oceanic and Atmospheric Administration, Seattle, Washington.

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

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

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

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

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

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

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

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

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

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

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

NRC 2010. Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Supplement 38 – Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3. Final Report. NUREG-1437, Supplement 38

NRC 2009. Biological Assessment to NMFS for Indian Point relicensing. Unpublished report transmitted to NMFS.

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

NRC 2011. Supplement to Biological Assessment to NMFS for Indian Point relicensing.

NYHS (New York Historical Society as cited by Dovel as Mitchell. S. 1811). 1809. Volume1. Collections of the New-York Historical Society for the year 1809.

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

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

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

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

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

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

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

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

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

Natural Resources, Brunswick, Georgia.

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

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

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

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

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

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

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

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

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

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

Swanson, C., D. Crowley, Y. Kim, N. Cohn, and D. Mendelsohn. 2011a. Part 2 of Response to the NYSDEC Staff Review of the 2010 Field Program and Modeling Analyis of the Cooling Water Discharge from the Indian Point Energy Center. Prepared for Indian Point Energy Center,

Buchanan, New York. ADAMS Accession No. ML 11189A026. Available URL: http://www.dec.ny.gov/permits/57609.html.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Figure 1

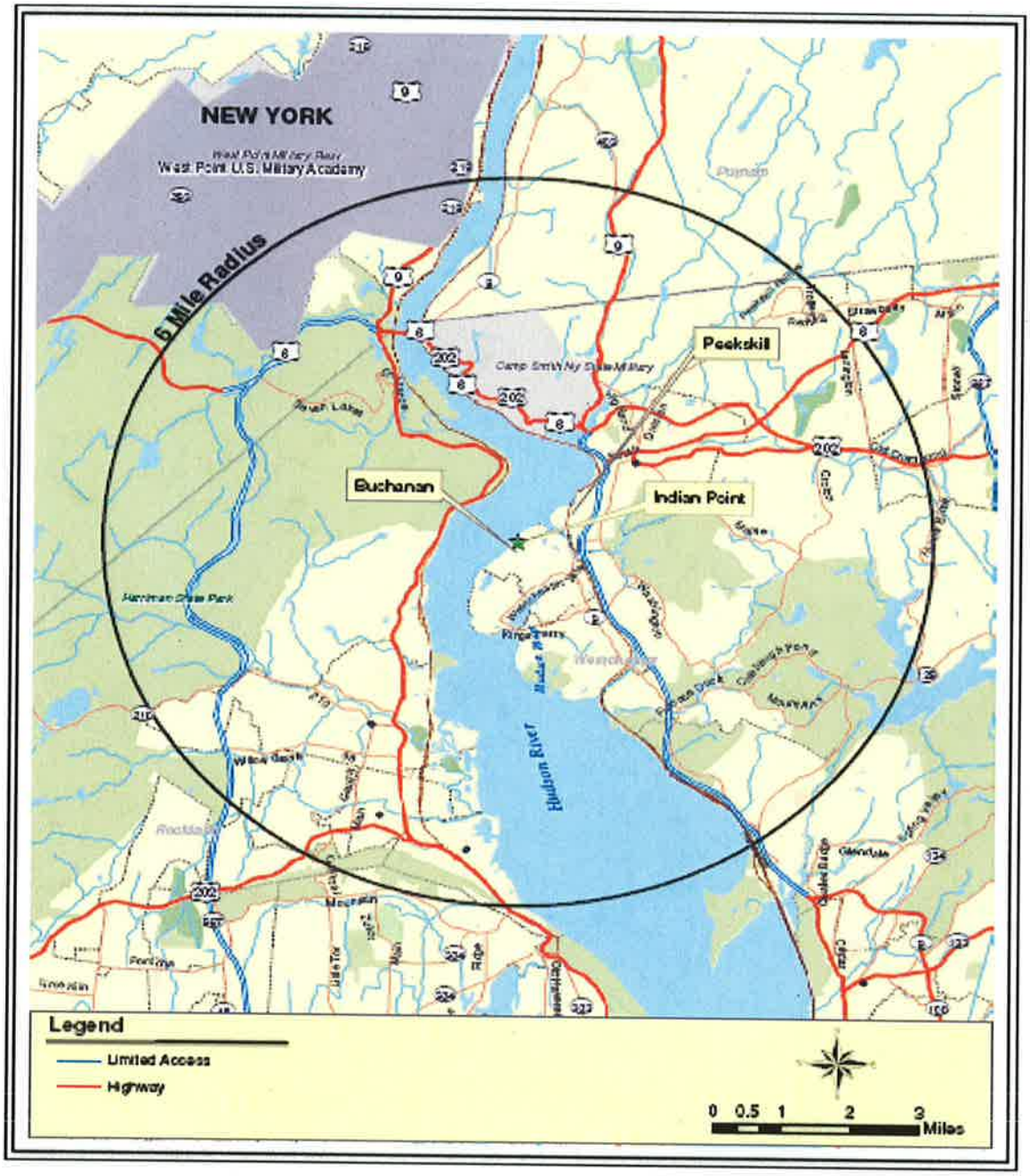
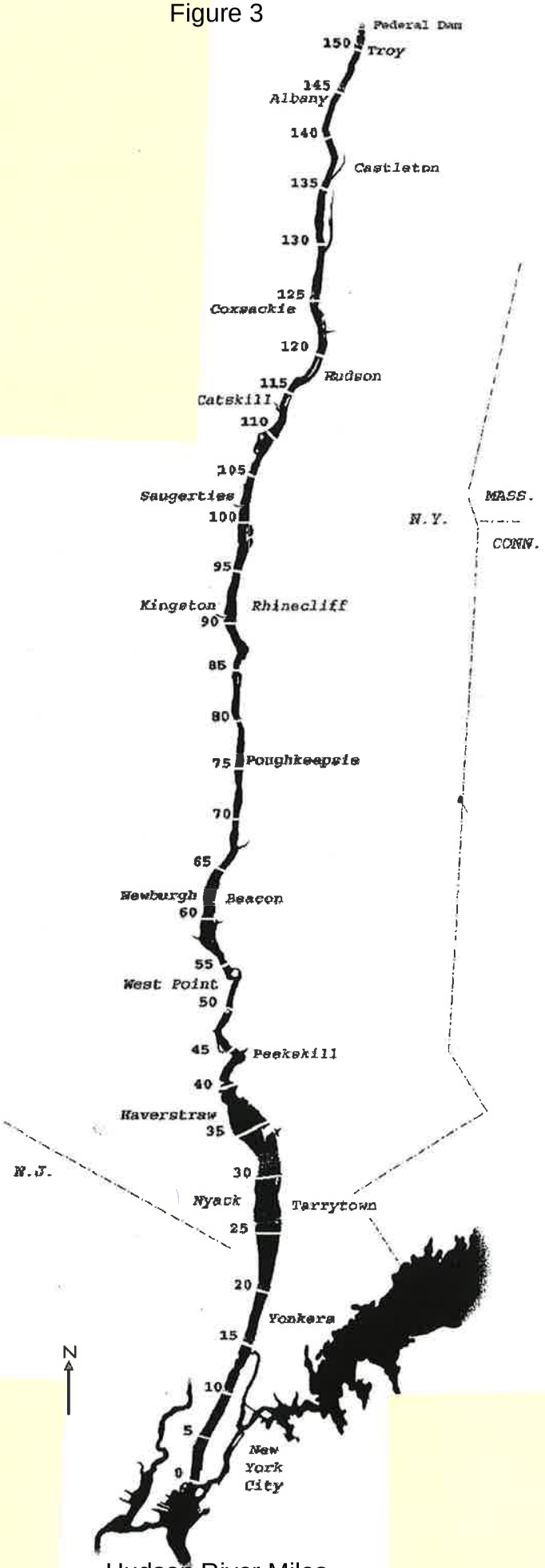

NEW YORK
West Point U.S. Military Academy
5 Mile Radius
Peekskill
Buchanan
Indian Point
Hudson River
Legend
Limited Access
Highway
0 0.5 1 2 3
Miles

Figure 2

Location of Indian Point, View 2

Figure 3



Hudson River Miles

Appendix I
Incident Report Shortnose Sturgeon Take – Indian Point

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

Observer's full name:_____
Reporter's full name:_____

Species Identification (Key attached):_____

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

Date animal observed:_____ Time animal observed: _____
Date animal collected:_____ Time animal collected:_____

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

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

Sturgeon Information:
Species _____

Fork length (or total length) _____ Weight _____

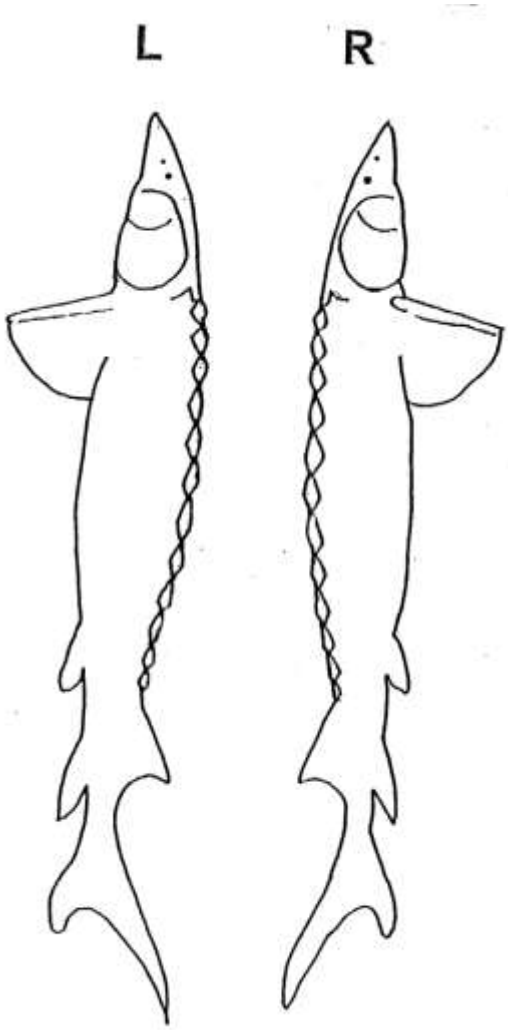
Condition of specimen/description of animal
_____
_____
_____
_____

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

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

Appendix I, continued

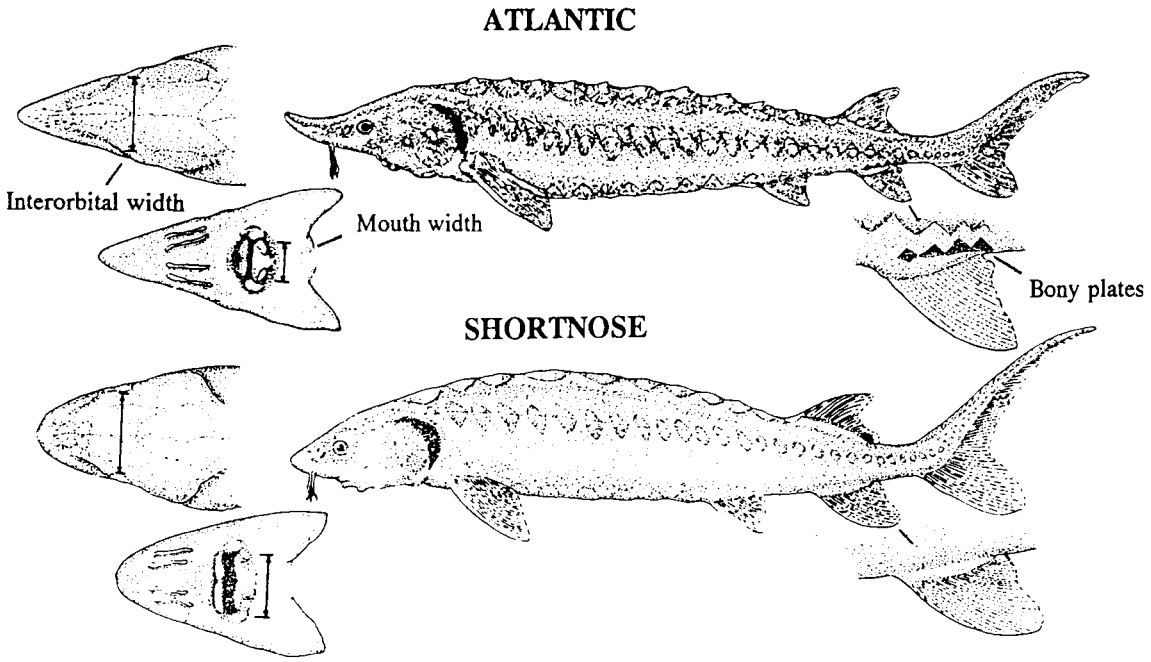
Draw wounds, abnormalities, tag locations on diagram and briefly describe below



Description of fish condition:

Appendix II

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



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

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

* From Vecsei and Peterson, 2004

APPENDIX III

Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

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

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

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

Storage of Sample

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

Sending of Sample

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

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

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

Figure 1

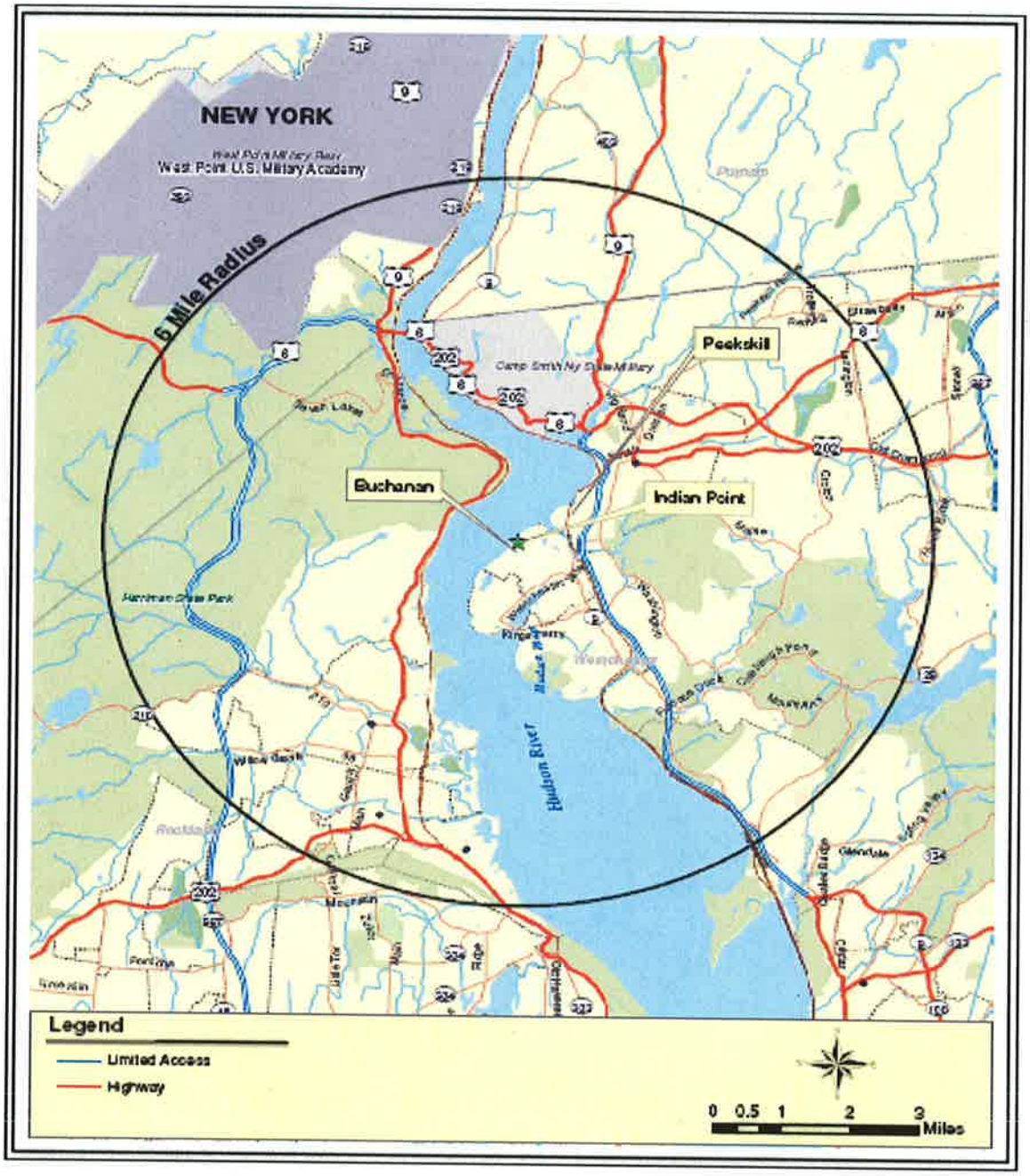
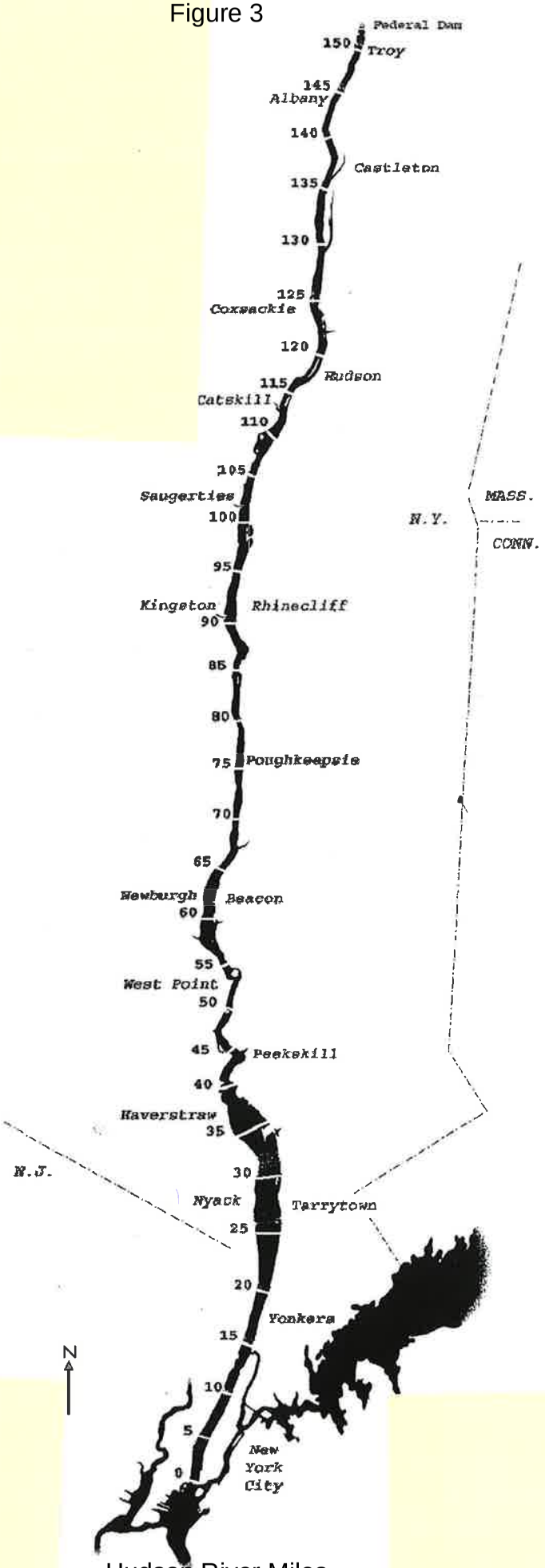

NEW YORK
West Point U.S. Military Academy
5 Mile Radius
Peekskill
Buchanan
Indian Point
Hudson River
Legend
Limited Access
Highway
0 0.5 1 2 3
Miles

Figure 2

Location of Indian Point, View 2

Figure 3



Hudson River Miles