UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JUL 2 4 2014

Supplemental Environmental Assessment (SEA)
On the Issuance of a Modified Scientific Research Permit (File No. 16436-01) to the New York State Department of Environmental Conservation, to Conduct Scientific Research on Endangered Shortnose and Atlantic sturgeon in the Hudson River.

[July 2014]

A Supplement to the 2012 EA entitled "*Environmental Assessment for the Issuance of 12 Scientific Research Permits for Research on Atlantic Sturgeon*" and a supplement to the 2011 EA entitled "*Environmental Assessment (EA) On the Effects of the Issuance of a Scientific Research Permit (File No. 16439) to Conduct Scientific Research on Shortnose Sturgeon in the Hudson River*"

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Abstract: In response to the receipt of an application from the New York State Department of Environmental Conservation (NYSDEC), NMFS, Office of Protected Resources (PR) proposes to modify Permit No. 16436 and terminate Permit No. 16439 pursuant to the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.). Both permits are held by the NYSDEC.

The Permit Holder proposes to continue studying the population dynamics and seasonal habitat use of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) authorized in Permit 16436 and proposes to consolidate the existing takes of shortnose sturgeon (*Acipenser brevirostrum*) in Permit 16439 and then terminate Permit No. 16439 upon issuance of the modification. The Permit Holder also requests increasing the numbers and procedures for taking both Atlantic and shortnose sturgeon to meet new objectives, including tracking movement, habitat and diet changes in response to major construction projects on the Hudson River. The modification would be valid through the expiration date of the original permit on April 5, 2017.

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CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

1.1 DESCRIPTION OF ACTION

The National Marine Fisheries Service (NMFS), Office of Protected Resources (NMFS PR) proposes to issue Permit Modification No. 16436-01 to the New York State Department of Environmental Conservation [hereinafter, Permit Holder, and Kathyrn Hattala, Responsible Party (RP)/Principal Investigator (PI)], NYSDEC, New Paltz, NY 12561, under Section 10(a)(1)(A) of the Endangered Species Act (ESA) of 1973 as amended (16 U.S.C. 1531 *et seq*.), and the regulations governing the taking, importing, and exporting of endangered and threatened species (50 CFR 222-226). This modification would be valid through April 5, 2017.

1.1.1. *BACKGROUND:*

In response to the receipt of an application to modify a scientific research permit (Permit No. 16436) from the NYSDEC, NMFS PR proposes to issue the proposed permit modification. The action would consolidate the take authorizing take of Atlantic sturgeon in the above mentioned permit with the take of shortnose sturgeon authorized in Permit No. 16439. The modification would also increase the numbers of animals of both species taken as well the types of research methods. The expansion of take would assist researchers in understanding impacts on the species related to changes in management objectives listed below. Once the modification is issued, Permit No. 16439 would be terminated. This analysis would thus facilitate a cumulative assessment of the potential impacts added from the proposed modifications on the human environment, including both of the targeted endangered species of sturgeon.

1.1.2 *PURPOSE AND NEED:*

The primary purpose of the permit modification would be to provide an exemption from the ESA prohibitions allowing "takes" of endangered species for bona fide scientific research. The need for issuance of the permit is related to NMFS's mandates under the ESA, specifically, the responsibility to protect, conserve, and recover threatened and endangered species under its jurisdiction. The ESA prohibits takes of threatened and endangered species with only a few very specific exceptions, including for scientific research and enhancement purposes. Permit issuance criteria require research activities are consistent with the purposes and policies of this federal law and will not have a significant adverse impact on the species. NMFS reviewed the proposed action to ensure all the proposed activities fulfill these permit issuance criteria.

1.1.3 *OBJECTIVES OF THE RESEARCH:*

The main research objectives of the proposed modification (File No. 16436-01) would be similar to those of the original individual permits (Permit Nos. 16436 and 16439); however, when the two permits are consolidated, these objectives would continue updating information on the abundance, population dynamics, seasonal movements, diet, and general ecology of both Atlantic and shortnose sturgeon in the Hudson River and estuary to facilitate recovery. The specific goals of research in this proposal have changed to accommodate new management objectives of the NYSDEC, including understanding the impacts on both species from the construction of the: (1) Tappan Zee Bridge over the Hudson River, (2) the laying of high voltage cable in the Hudson River by the Champlain Hudson Power Express project, and (3) measuring high loads of contaminants identified in the Hudson River. These changes would be reflected in the numbers and types of activities highlighted in Section 2.2.1.2. (*Proposed and Authorized Take*) of this SEA.

1.2 OTHER EAs/EISs INFLUENCING THE SCOPE OF THIS SEA

Most recently, necessitated by the listing of Atlantic sturgeon in five separate Distinct Population Segments (DPSs) for Atlantic sturgeon, a 2012 EA (NMFS 2012a), was prepared entitled "*Environmental Assessment for the Issuance of 12 Scientific Research Permits for Research on Atlantic Sturgeon"* to evaluate the environmental impacts resulting from the issuance of 12 scientific research permits. Permit No. 16436 (NYSDEC), authorizing the take of Atlantic sturgeon in the Hudson River and Estuary, was one of the permits prepared in the prior action where its environmental impacts were evaluated. Environmental impacts evaluated in this EA included effects on the Biological Environment from general research on the target species as well as the potential impacts on the non-targeted resources, bycatch, and aquatic nuisance species. Impacts to Social-Economic and Physical Environments (e.g., Marine Protected Areas, Sanctuaries, Parks, or Historic Sites; EFH; and Critical Habitat) were also discussed. The EA resulted in a FONSI, concluding that issuance of each of the 12 permits would not result in significant impacts to any portion of the human environment in the locations where permitted.

Other EAs affecting the scope of this SEA include shortnose sturgeon research authorized in Permit No. 16439 in the identical action area of the Hudson River. In November 2011 an EA (NMFS 2011a) entitled "*Environmental Assessment (EA) on the Effects of the Issuance of a Scientific Research Permit (File No. 16439) to Conduct Scientific Research on Shortnose Sturgeon in the Hudson River* was produced, evaluating similar environmental impacts in the Hudson River and Estuary, and also resulted in a FONSI.

The prior five-year scientific research permit authorizing study of shortnose sturgeon in the Hudson River was Permit No. 1547. The EA (NMFS 2006a) was prepared in October 2006 entitled "*Environmental Assessment of Issuance of a Scientific Research Permit to New York State Department of Environmental Conservation (File No. 1547*)" and evaluated the effects for non-lethal research capturing up to 500 adult and juvenile shortnose sturgeon annually with gill nets, measuring, weighing, scanning for tags, PIT and Carlin tagged (if untagged), and releasing. The activities were not expected to significantly affect the environment.

Subsequently, a March 2007 (NMFS 2007) [File 1547-01] SEA was produced entitled "*Supplemental Environmental Assessment (SEA) of the Issuance of a Scientific Research Permit Modification (File No. 1547-01) to New York State Department of Environmental Conservation for Conducting Research on Endangered Shortnose Sturgeon*." The additional effects analyzed were associated with newly proposed genetic tissue sampling. The new activity was not expected to significantly affect the environment.

Thereafter, a March 2009 (NMFS 2009) SEA was prepared entitled "*Supplemental Environmental Assessment (SEA) of the Issuance of a Scientific Research Permit Modification (File No. 1547-02) to New York State Department of Environmental Conservation for Conducting Research on Endangered Shortnose Sturgeon*. This SEA supplemented the above analysis specific to potential additional impacts associated with the then newly proposed gastric lavage procedure. The new activity was concluded not to significantly affect the environment.

Each of these prior NEPA documents is referenced to facilitate the current action, which would combine the take of both shortnose and Atlantic sturgeon in the same action area.

1.3 SCOPING SUMMARY

The Council on Environmental Quality's (CEQ) regulations implementing the National Environmental Policy Act of 1969 (NEPA; 40 CFR 1502.9) require supplemental analysis when (1) substantial changes in proposed action that are relevant to environmental concerns; or (2) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. With respect to the proposed action, the modification proposes significant changes in the permitted authority to take shortnose and Atlantic sturgeon.

Consultation under section 7 of the ESA is required because Section 7 of the ESA requires consultation with the appropriate federal agency (NMFS or the U.S. Fish and Wildlife Service, (USFWS)) for federal actions that ―may affect a listed species or adversely modify critical habitat. NMFS' issuance of the current permit modification is a federal action subject to these section 7 consultation requirements.

In identifying public concerns as a part of the scope of this federal action, a Notice of Receipt of the application was published in the *Federal Register*, announcing the availability of the permit modification and related documents for public comment (File No. 16436-01; 26724 FR May 9, 2014). However, no comments were received from the public regarding this application. Comments from NMFS Greater Atlantic Region Fisheries Office (GARFO) were also solicited and appropriately addressed in the decision memos.

1.4 APPLICABLE LAWS AND NECESSARY FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

The applicable laws and necessary federal permits, licenses and entitlements in this SEA have not changed from those described in the original action in File 16436 in the 2012 EA (NMFS 2012a) analyzing impacts from issuing research permits for Atlantic sturgeon studies; and also those described in File Nos. 16439 (NMFS 2011a); and 1547 (NMFS 2006a), analyzing impacts for issuing permits for shortnose sturgeon research. Applicable laws in this SEA, including those for NEPA, ESA, MMPA, and as applied in consultation with other appropriate federal and state agencies, are referenced within the prior NEPA documents.

CHAPTER 2: ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1. ALTERNATIVE 1 – NO ACTION ALTERNATIVE

Under the first No Action Alternative, the modification of scientific research Permit No. 16436, authorizing consolidated takes of shortnose with those of Atlantic sturgeon and also allowing for increased numbers of take of each species due to new research objectives, would not be issued at this time. Thus, each of the existing permits, Permit No. 16436 for Atlantic sturgeon and Permit No. 16439 for shortnose sturgeon, would remain in effect through expiration, allowing research to continue as originally authorized until either of the permitted terms reached its expiration date or was terminated.

2.2 ALTERNATIVE 2 – PROPOSED ACTION

Under the Proposed Action Alternative, the permit modification No. 16436-01 would be issued, consolidating takes of shortnose sturgeon under Permit No. 16439. At issuance of the modification, Permit No. 16439 would be terminated. The Proposed Action would also increase the number of takes of each species, exempting the applicant from ESA prohibitions

for taking either species during conduct of the current and the newly proposed research activities until April 5, 2017 (See Section *2.2.1.2.* and Appendix No. 1, Table 1for a description of the proposed take in the modification). The permit would contain terms and conditions mitigating impacts on the environment.

2.2.1. *DESCRIPTION OF THE PROPOSED ACTION*

2.2.1.1. *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."

As illustrated in Appendix No. 2, the map of the Hudson River estuary and locations of key critical habitat is highlighted. The proposed action area consists of the Hudson River estuary and its tidal influences along its entire 245 km length from New York Harbor to the Federal Dam at Troy, NY. The upper two-thirds of the river is freshwater with saltwater intrusion penetrating the lower third as far north as West Point (km 83) in the late spring. During the summer months it can move as far north as Poughkeepsie (km 122). The river is classified as a 'drowned' river valley, straight and fairly deep in some sections, especially in the Hudson Highlands near West Point, where the river is greater than 60 m in depth. In the lower 70 km, the river opens into two large wide, shallow "bays", Haverstraw Bay and the Tappan Zee, before narrowing down to a deep section just above New York harbor.

2.2.1.2. PROPOSED OBJECTIVES AND SUMMARY OF TAKE

- ***Summary of Proposed Objectives of Permit Modification No. 16436-01:*** The applicant's modification proposes separate actions affecting the environment differently. These are: (1) Consolidating currently authorized take of shortnose and Atlantic sturgeon permitted for concurrent sampling in the Hudson River and Estuary; subsequently, the shortnose sturgeon Permit No. 16439 would be terminated; (2) Increasing the numbers of take for procedures authorized for both shortnose and Atlantic sturgeon, reflecting more intensive sampling; (3) Adding a laparoscopic procedure to biopsy liver samples associated with contaminant research; (4) Adding a electronarcosis procedure associated with anesthesia in freshwater during surgical or other research activities; (5) Increasing the number of incidental (accidental) mortality to three animals of each species annually; and (6) Changing the start date for the annual reporting period for research beginning and ending on the calendar year, or January 1 to December 31. (See Table 1 below, Section *4.2.2.1,* and Appendix No. 1 for a summary of objectives and proposed take in the modification).

With exception of a laparoscopic biopsy procedure and an electro-narcosis anesthetic procedure newly proposed in the modification to determine the level of contaminants of polychlorinated biphenyls **(**PCBs) and dioxin (TCDD) and introduce a new method for anesthesia, respectively, the impacts of all other procedures used in File 16436 for Atlantic sturgeon and in File No 16439 for shortnose sturgeon were previously discussed in the original NEPA documents and biological opinions for these actions.

Table 1. Current and Proposed Research Objectives of Shortnose and Atlantic Sturgeon in Modification 16436-01

Research Objectives	Shortnose Sturgeon		Research Objectives	Atlantic Sturgeon	
	Current Take (Permit 16439)	Proposed Take (Mod Permit 16436-01)		Current Take (Permit 16436)	Proposed Take (Mod Permit 16436-01)
SNS Bycatch (Assoc. w/Juv ATS Abundance Index)	100 Cap/PIT/Release (All sizes, Annually) ---------- 40 Lavage (All sizes, Annually)	200 Cap/PIT/Release (all sizes, Yrs 2-5=*NYDEC*) ---------- 30 Adt, SubA/Lavage 30 Juv/ Lavage (yr2-3= *DEC/TZee*)	Juvenile ATS Abundance Index ---&--- Tappan Zee (TZee) Bridge Monitoring	260 Cap/PIT/Release (Juvenile Yr 1-5) ---------- 40 Lavage (Juv Yr 1-5)	540 Cap/PIT/Release (Juvenile; Yr 2-5= *NYDEC*) ---------- 30 Lavage (Juvenile; Yr2-5=*TZee*) 30 Sonic (Juvenile; Yrs 2-5 = *TZee*)
SNS Adult-SubA-Juv Sonic Tagging (Movement & Habitat Use)	50 Adt/sonic tag (yr 1) 30 SubA/sonic tag(yr1-3) 20 Juv sonic tag (yr1-3)	30 Adt/SubAd/sonic (*TZee*) 30 Juv/sonic tag (*TZe* e) (Yrs 2-3)	Adult Spawning Stock Characteristices (Adlt/SubA)	150 Cap/PIT/Release (Adult/SubA, Yr 1-5) ---------- 50 Sonic (Int or Ext) Tags (Adlt/SubA, Yr 1-5)	320 Cap/PIT/Release (Adult/SubA, Yr 2-5=*NYDEC*) ---------- 30 Sonic (Adlt/SubA; Yr 2)=*TpZee* 50 Sonic (Adl/SubA; Yr3-5)=*CHPE* *30 Lavage (Adt/SubA;Yr2-5=TZee)*
Population/Age Estimate (SNS Adlt/SubA/Juv)	200 Fin Ray Section (Yrs 4-5) (Adlt/SubA/Juv) ---------- 2000 Cap/PIT/Recap (Yrs 4-5) (Adlt/SubA/Juv)	NO CHANGE	Population Estimate (Juvenile ATS)	25/50* (Int/Ext) Sonic Tags (Juvenile Yr 1-3) ---------- 1,000 Cap/PIT/Recap (Juvenile,Yr 4,5)	NO CHANGE
Contaminant Research	NONE	3 Liver Biopsy:Laparoscope (Adult/SubA/Juvenile) (NYDEC: Any 2yrs)	Contaminant Research	NONE	3 Liver Biopsy: Laparoscope (Juvenile) (NYDEC: Any 2 yrs)
Anesthesia with Electro-narcosis (EN)	NONE	Add Option for Surgical Anesthesia with EN, when appropriate in freshwater; and Add MS-222 (220ppm Protocol) in brackish water	Anesthesia with Electro-narcosis (EN)	NONE	Add Option for Surgical Anesthesia with EN, when appropriate in freshwater; and Add MS-222 (220ppm Protocol) in brackish water
Authorized Mortality	Accidental Mortality Yr 1-3=0 Yr 4-5=2 (Adult, SubA, or Juv)	3 Accidental Mortality (Adult/SubA/Juv, Annual)	Authorized Mortality	2 Accidental Mortality (Juvenile, Annual)	3 Accidental Mortality (Juvenile, Annual)

* 25/50 = During the first year, 25 sonic tags (internal/external) will be used; during the second and third years, 50 sonic tags (internal/external) will be used.

Life Stage: Atlantic sturgeon (TL): Adult > 1,300mm; sub-adult= 1000 - 1300 mm; juvenile =< 1000mm

Life Stage : Shortnose sturgeon (=TL): Adult = > 550 mm; sub-adult = 400 - 550 mm; Juvenile = < 400 mm.

NYSDEC = Ongoing research by the New York State Department of Evironmental Conservation ;

TZEE = New project associated with Tappan Zee Bridge ;

CHPE = the Champlain Hudson Power Express project;

- ***Narrative Summary of Objectives*:** The NYSDEC currently possesses two federal endangered species scientific research permits: # 16436 for Atlantic sturgeon and #16439 for shortnose sturgeon to exempt the state agency from ESA section 9 ESA prohibitions in their collection of these species. These programs in the past primarily targeted Atlantic sturgeon and include an annual relative abundance survey for Atlantic sturgeon juvenile fish in late winter early spring, followed by an adult spawning stock survey in June. During the juvenile Atlantic index survey, shortnose sturgeon were found to be co-occurring with young Atlantics and were also captured as bycatch; hence, more directed research for shortnose sturgeon was developed to study the species. In this effort, the NYSDEC initiated a small sonic tagging program for shortnose sturgeon in 2012 with an expanded number of fish being internally

sonic tagged in 2013. Objectives of this program are to continue in the current modification by determining seasonal movement and habitat use of shortnose in comparison to juvenile Atlantic sturgeon, and to use the data for designing a mark /recapture program estimate the shortnose sturgeon population size for juvenile, sub-adult, and adult life stages in the Hudson River.

The NYSDEC also proposes to continue its ongoing juvenile index for Atlantic sturgeon relative abundance and spawning stock surveys. In the expanded effort proposed by the modification, the proposed take numbers are increased for both Atlantic and shortnose sturgeon. New York also proposes to conduct two new directed studies, including an acoustic telemetry survey of spawning adult Atlantic sturgeons, and an acoustic tracking survey of juvenile Atlantic sturgeon for three years. This effort is to be followed by a large scale mark and recapture population abundance estimate of juvenile Atlantic sturgeon for an additional two years, and perhaps a third year in the next permit cycle.

In addition, two other projects are planned, both of which are designed to determine the impacts of construction project activities in the river on the listed sturgeon. The first project in its final planning stages, the Champlain Hudson Power Express (CHPE), is to place a 1000 MW direct current electric transmission line down the axis of the Hudson River from Saugerties southward to New York City, with the exception of Haverstraw Bay. Since the power line will be routed through the Atlantic sturgeon spawning areas near Hyde Park and Newburgh Bay, along with being present in nursery areas for juvenile fish, research emphasis will emphasize tagging and monitoring the impacts on the adult/sub-adult stock population. The second project addresses impacts to sturgeon (both species) related to the construction of the replacement bridge over the Tappan Zee, including extensive construction and pile driving at the site as well as dredging a large area of benthic habitat below the site. Research emphasis in monitoring these impacts will include tagging and tracking movement and documenting dietary changes in different life stages of both species through gastric lavage.

The Permit Holder has requested two new objectives in the modification, including laparoscopic liver biopsy for contaminants research, and two additional anesthetic processes including rapidly induced anesthesia through electro-narcosis and using high-rate MS-222 protocol.

Lastly, the Permit Holder has requested three annual unintended mortalities or serious harm resulting from research annually for each species. This request was based on the cumulative stress anticipated from the additional volume of research activity required to sample sturgeon and meet the researcher's objectives.

- ***Summary of Proposed Take in Permit Modification No. 16436-01:***

Shortnose Sturgeon—*(Note: Takes formerly in Permit No. 16439 will be consolidated with Modified Permit No. 16436-01. Net-change proposed in take levels are highlighted in* ***bold)****.*

- 200 Adult/SubA/Juvenile SNS (Yr 2-5) (Bycatch in ATS Research) =***Increase of 100 for*****:** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, photograph*
- 30Adult/SubA /30 Juvenile SNS(2yrs) (Tappan Zee /NYDEC Project (Lavage) = ***Increase of 20 of all sizes for*****:** *capture; handle; measure; weigh; anesthetize; lavage stomach sample; PIT tag; Floy tag; genetic tissue, photograph; release*

- 30 SubA: TZee/30 Juvenile :TZee (3yrs) (Sonic Tagging)= ***Increase of 10 Juveniles for*:** *capture; handle; measure; weigh; anesthetize; sonic tag; PIT tag; Floy tag; genetic tissue, photograph; release*
- 200 Adult/SubA/Juveniles (yr 4-5) (Age/Growth Analysis)= ***No Change for***: *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, anesthetize; fin ray section clip; photograph; release*
- 2,000 Adult/SubA/Juveniles (yr 4-5) (Population Estimate)= ***No Change for***: *capture/recapture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, photograph; release*
- 3 Adult/SubA/Juvenile (2 yrs) (NYDEC Laparoscopic Biopsy of Liver: Contaminants)=***New Procedure for***: *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, photograph*; *anesthetize; laparoscopic biopsy*
- 3 Adult/SubA/Juvenile (annual) (Accidental Mortality)= ***Increase of 1***

Atlantic Sturgeon: ***(****Net-change proposed in take is highlighted in* ***bold)****.*

- 540 Juvenile (yrs 2-5) (NYDEC: Juvenile Abundance–Index**)=*Increase of 210 for:*** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, photograph*
- 30 Juvenile (yrs 2-5) (Tappan Zee Project– Lavage)**= *Decrease of 10 for*:** *capture; handle; measure; weigh; anesthetize; lavage stomach sample; PIT tag; Floy tag; genetic tissue, photograph*
- 30 Juvenile (yrs 2-5) (Tappan Zee Project– Sonic Tagging)**=*Increase of 30 for***: *capture; handle; measure; weigh; anesthetize; Internal sonic tag; PIT tag; Floy tag; genetic tissue, photograph*
- 320 Adult/SubA (yrs 2-5) (NYDEC: Adult Spawning Stock– Characteristics) = ***Increase of 170 for*:** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, photograph*
- 30 Adult/SubA (yr 2) (Tappan Zee Project: Adult Spawning Stock)–Sonic Tagging) = ***Increase of 30 for 2014 for*:** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, anesthetize; internal sonic tagging; photograph*
- 50 Adult/SubA (yrs 2-5) (CHPE Project: Adult Spawning Stock– Sonic Tagging)= ***No Change for*:** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, anesthetize; internal/external sonic tagging; photograph*
- 30 Adult/SubA (yr 2-5) (Tappan Zee Project: Adult Spawning Stock)–Lavage) = ***Increase of 30 for 2014 for*:** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, anesthetize;lavage; photograph*
- 50 Sm Juvenile (yrs 2-3) (NYDEC: Small Juvenile Population Estimate– Sonic Tagging)= ***No Change for*:** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, anesthetize; internal/external sonic tagging; photograph*
- 1,000 Sm Juvenile (yr 4-5) (NYDEC: Small Juvenile Population Estimate: Capture/Recapture) =***No Change for***: *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, photograph*
- 3 Juvenile (2 yrs) (NYDEC Laparoscopic Biopsy of Liver: Contaminants)=***New Procedure for*** *capture; handle; measure; weigh; PIT tag; Floy tag; genetic tissue, photograph;* ***rapidly anesthetize (MS-222 & EN)****; laparoscopic biopsy*
- 3 Juveniles (yrs 2-5) (Accidental Mortality)=***Increase of 1***

2.2.1.3. DESCRIPTION OF NEWLY PROPOSED RESEARCH

- ***Contaminant Research: Sampling of Liver and Oocyte Tissue Using Laparoscopic Biopsy***

The Permit Holder has newly proposed to take biopsy samples of liver and oocyte tissue laparoscopically from three wild sturgeon of each species in association with Isaac Wirgin (CI) of the New York Medical University to determine the levels of congener-specific tissue burdens of PCBs, PCDDs (dioxins), and PCDF (furans) in environmentally exposed sturgeons from the Hudson River.

Laparoscopy and Biopsy: Laparoscopic procedures would be used to collect organ samples from three fish of either species according to the procedures of Matsche et al (2011 & 2013). Two 6-mm cannulae would be installed in incisions in the ventral body wall, and the coelom would be partially inflated with pressurized ambient air. Cannulae allow internal access for a laparoscope, with video imaging system, and a 5-mm cut-biopsy forceps that would be used to collect tissue samples of the liver and oocytes. The volume of liver tissue collected by a single 5-mm biopsy (≈ 100 mg) is insufficient for analysis. Therefore, multiple biopsies will be collected from each organ for a total of at least 0.5 g of tissue per organ. If necessary, the body cavity would be insufflated with ambient air by attaching a battery-powered air pump to the insufflation port of the trocar increasing the working space within the body cavity. Following procedure, instruments would be removed, air remaining from insufflation would then be expelled from the coelom with gentle abdominal pressure and each incision would be closed with PDS II Plus, size 2-0 sutures (Ethicon Inc., Somerville, NJ, USA). Following recovery, fish would be placed in a live-well until fully recovered, and then released within 20 minutes of the start of procedures.

Sampling efforts would occur on three fish of each species annually for two years beginning in 2014 and would focus on shortnose and Atlantic sturgeon collected in Haverstraw Bay where NYSDEC collection effort in recent years has yielded moderate numbers of juvenile Atlantic sturgeon and lesser numbers of adult shortnose sturgeon. Liver and ovary tissues have few, small blood vessels peripherally where biopsies are typically collected. Thus, because the potential for hemorrhaging is low, multiple biopsies could be collected from the exposed margins of elongate liver lobes.

- ***Rapid Induction of Anesthesia for Laparoscopic Surgery*:**

Depending on the salinity of the water, upon capture, three sturgeon of each species would be placed in a live-well and then either anesthetized using either MS-222 in brackish waters (>3ppt) or using Electro-narcosis (EN) when animals are captured in freshwater (<3ppt).

MS-222: An alternative method proposed for rapid induction of anesthesia using MS-222 (tricaine methane sulfonate) would be used by the Permit Holder when animals are captured from brackish waters prior to performing laparoscopic biopsies of the liver and oocyte tissues. The proposed rapid induction anesthesia protocol using MS-222 calls for using a buffered solution of 250 mg/L MS-222 followed immediately by an 87.5 mg/L maintenance solution of MS-222 during surgery (Matsche 2011 & 2013). Each animal chosen for laparoscopic examination would be selected in excellent, non-stressed condition when netted. When removed from the net, each fish would be immediately transported (two to three minute transport) to a near-by field laboratory providing a 110-v electrical outlet to operate the lab

and surgical equipment. Upon arrival, the animal would be anesthetized in the buffered solution of MS-222 and fitted with a heart rate monitor to assist determining when the state of surgical anesthesia has been reached. The time required to reach the proper plane of anesthesia would average 2 to 7 minutes (Matsche 2013).

Electro-narcosis: Any shortnose or Atlantic sturgeon collected in fresh water may be anesthetized using non-pulsed direct current electro-narcosis (EN) following the technique of Hudson et al. (2011). This optional use of EN would be limited to any animal captured in freshwater environments (<3ppt) because of the procedure's inability to operate in more saline waters.

EN is a method of rapid inducement of anesthesia using a low voltage/amperage electrical current while minimizing stressful effects on animals. Using the method described by Parker et al., (2002), Hudson et al (2011), and Balasik et al (2013), non-pulsed DC voltage (0.3-0.5 V/cm, 0.01A) is used to immobilize fish. In this procedure, fish are placed in a tank with a screen anode at one end of the tank and a cathode screen at the other end. As voltage is applied quickly to the anode (1-2 sec), the subject fish loses equilibrium and relaxes, sinking to the bottom of the containment and exhibiting complete loss of equilibrium, decreased muscle tone and reaction to massive stimulation, while maintaining a depressed ventilation rate and heart rate initially. At the moment the animal is in a relaxed state, the voltage is then adjusted downward until the fish regains strong opercula movement in an immobilized state. Fish are supported with netting in a position such that only their back or ventral surfaces emerge from the water before conducting other procedures. Fish will be monitored continuously during procedures, assisted with forced-ventilation during recover and released only after full equilibrium is achieved. Within a few seconds of removing the applied direct current, fish regain movement and normal activity.

CHAPTER 3: AFFECTED ENVIRONMENT

The 2012 EA (NMFS 2012a) produced for Atlantic sturgeon research and the 2011 EA (NMFS 2011a) produced for shortnose sturgeon research in the Hudson River, described the affected environment for the proposed research on the respective species in the identical action area proposed in the current modification. This SEA considers the additional potential impacts to the human environment not considered in prior EAs, including the social and economic resources, physical, and biological affects relevant to the permit modification's issuance. Where overlapping, those impacts considered part of prior EAs or SEAs or biological opinions produced for issuance of the prior permits, are incorporated by reference in the current modification and are available upon request.

3.1 SOCIAL AND ECONOMIC RESOURCES

The proposed action does not affect distribution of environmental burdens, access to natural or depletable resources or other social or economic concerns. Nor does it affect traffic and transportation patterns, risk exposure to hazardous materials or wastes, risk contracting disease, damages from natural disasters, food safety, or other aspects of public health and safety. Thus, effects on such resources will not be considered further.

3.2 PHYSICAL ENVIRONMENT

The topics of discussion referenced in the 2012 EA (NMFS 2012a) describe the physical environment in the action area, including ocean and coastal habitats, marine protected areas, critical habitat, essential fish habitat, historic places, and also cultural or scientific resources.

3.2.1. *OCEAN AND COASTAL HABITATS*

The proposed modification targets shortnose and Atlantic sturgeon and would not affect habitat. The methods of capture, including anchored or drifted gill nets and trawl nets would have little to no impact to the sediment or other bottom habitat in the research action area in the Hudson River (NMFS 2012a). Furthermore, no critical habitat was identified in the Hudson River which would be impacted by the proposed research. Thus, based on the proposed research methods in the permit, NMFS concludes that the proposed action would not involve substantive alteration of substrate, movement of water or air masses, or other interactions with physical features of ocean and coastal habitat.

3.2.2. *SCIENTIFIC, CULTURAL, AND HISTORICAL RESOURCES*

There are no districts, sites, highways or structures listed in or eligible for listing in the National Register of Historic Places in the action area. The proposed action represents the use of shortnose and Atlantic sturgeon life stages for scientific research purposes and does not preclude their availability for other scientific, cultural, or historic uses. Thus, effects on such resources will not be considered further.

3.2.3. *UNIQUE AREAS*

The action would not take place in any sanctuaries, reserves and conservation areas. No other park lands, prime farmlands, wetlands, or wild and scenic rivers are found within the action area. The proposed action is directed at shortnose and Atlantic sturgeon and would not alter unique areas including protected areas and essential fish habitat (EFH) which were concluded not likely to be significantly impacted by the proposed action in the 2011 and 2012 EAs for the Permit Holder's prior actions for shortnose sturgeon and Atlantic sturgeon. Thus, effects on such unique areas will not be considered further in this SEA.

3.3 BIOLOGICAL ENVIRONMENT

3.3.1. *BIOLOGICAL DIVERSITY AND ECOSYSTEM FUNCTION*

The proposed action is directed at targeting the shortnose and three DPSs of the Atlantic sturgeon in the same action and does not interfere with benthic productivity, predator-prey interactions or other biodiversity or ecosystem functions. Nor will the modification affect their diet or foraging patterns. Further, the proposed action does not involve activities known or likely to result in the introduction or spread of non-indigenous species, such as ballast water exchange. However, the modification does propose greater numbers of animals taken whereby the level of incidental mortality or harm to shortnose sturgeon and juvenile Atlantic sturgeon each year would be increased to three for each species annually.

3.3.2 *ESA TARGET SPECIES AFFECTED BY THE PROPOSED MODIFICATION*

The biological environment for the proposed research modification was evaluated in the 2012 EA (NMFS 2012a) for each of the designated DPSs of Atlantic sturgeon coast-wide; and also in the 2011 EA (NMFS 2011a) for shortnose sturgeon research in the same action area. The target species of this SEA include the following listed species, including each of the DPSs that NMFS anticipates would be captured within the action area of the Hudson River.

Common Name	Scientific Name	ESA Status
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
GOM DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Threatened
New York Bight DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
Chesapeake Bay DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered

3.3.2.1. *STATUS OF THE TARGET SPECIES*:

The status of both of the target species is referenced in the related NEPA documents, including the 2012 EA (NMFS 2012a) prepared for the issuance of the Permit Holder's original Permit No. 16436 authorizing the Permit Holder's Atlantic sturgeon research, as well as Permits No. 16439 (NMFS 2011a), authorizing the Permit Holder's respective shortnose sturgeon research. These NEPA documents also describe the Atlantic sturgeon listing, providing life history information relevant to the status of each of the DPSs designated for the Atlantic sturgeon. The biological opinions produced for issuance of above permits also provide information on species' life history, habitat and distribution, and other factors necessary for survival, and provide the background for analyses to determine whether the actions would adversely affect the target species (NMFS 2012b and NMFS 2011b). These documents are incorporated by reference and are available upon request.

- **Abundance of Shortnose Sturgeon in the Hudson River Action Area**

There is general agreement that the Hudson River population is the largest and healthiest shortnose sturgeon riverine population. 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.

Bain et al. (2000) compared their spawning population estimate of 56,708 to Dovel et al. (1992) estimates of 12,669 and 13,844 in 1979 and 1980 respectively. While Bain et al. (2000) indicated a significant increase of approximately 400% was observed in population size between 1979 and 1997 (18-year span), comparison of the total population estimates (61,000 to 30,000) indicates size of the population doubled.

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 current information available on the current status of the Hudson River population of shortnose sturgeon and suggest that the population is relatively healthy, large, and particular in habitat use and migratory behavior (Bain et al. 1998).

- **Abundance of Atlantic Sturgeon in the Hudson River Action Area**

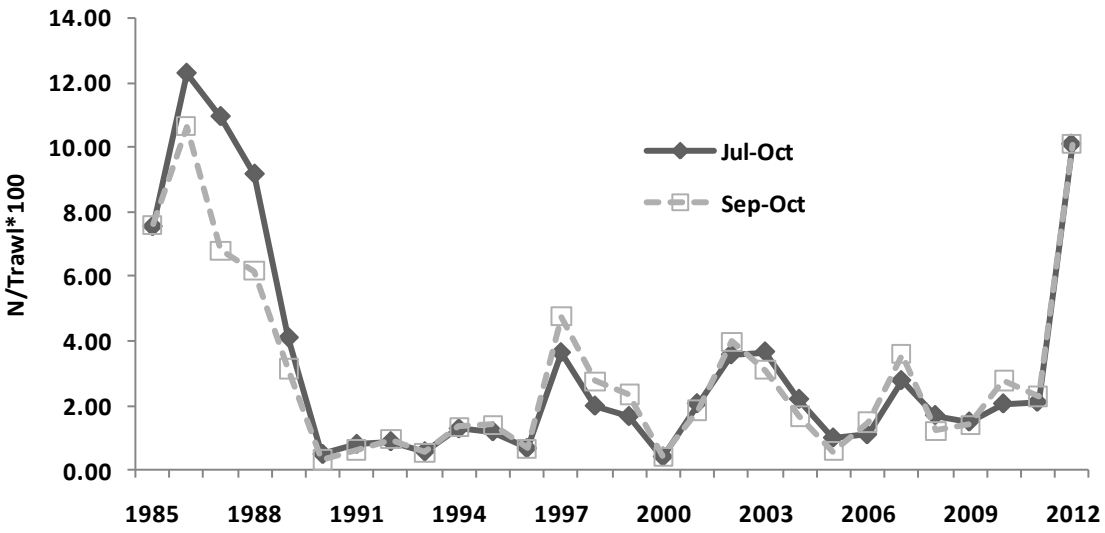
The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800's is unknown, but has been conservatively estimated at 10,000 adult females (Secor 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor 2002; ASSRT 2007; Kahnle *et al.*, 2007). As described, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). Kahnle *et al.* (1998; 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985- 1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment.

However, as several critiques have noted (see Dadswell and Nack 2012), this population estimate is for the mature adult portion of the population, not the total population. The 870 number was reported conservatively low as it was calculated using an exploitation rate (total mortality estimate calculated from the age structure of adult fish, by sex, harvested in the Hudson River), resulting in the population estimate equaling the exploitation of mature fish as a function of harvest of mature fish.

Nevertheless, more recent studies and observations conducted by the NYSDEC's research, assessing the abundance of Atlatnic sturgeon juveniles using with Didson and sidescan sonar since 2012, indicates a sizeable migration of adults and sub-adult animals in the Hudson River (Dunton, K.; Kahnly, A.; Hattala, K; and Mohler, J.; Pers. Comm, 2013). Additional side-scan sonar work conducted by Dr. Dewayn Fox, University of Delaware, has confirmed the presence of many more fish than the NYSDEC samples with fish appearing in areas unavailable to gear.

In addition, Entergy Nuclear Operation's contractor, Normandeau Associates, Inc. (Permit No. 17095-01; NMFS 2013), conducts the Fall Shoal Survey (FSS). The NYSDEC uses capture data of Atlantic and shortnose sturgeon to then calculate an ancillary index for tracking abundance as total catch divided by the net-hours and further adjusted through covariance analyses for the location of the salt front relative to sampling. Recent 2012 FSS sampling resulted in the capture of a large number of juvenile ATS indicating a significantly large cohort of Atlantic sturgeon produced in the river in 2011, signaling an increase in abundance is possibly occurring in the Hudson stock. For annual comparison purposes, the entire time series of data of the FSS survey since 1985 is highlighted in Figure 1 below.

Figure 1. CPUE of juvenile Atlantic sturgeon collected by beam trawl in the Hudson River Fall Shoals Survey. Solid line= Jul-Oct index, dotted line = Sep Oct index.



Significant to the data represented in Figure 1 is the period fom August 28, 2012 to present where Atlantic sturgeon capture rate is 1 fish per 9.5 for beam trawl samples; and 1 fish per 5.8 for striped bass trawls. However, from 1999-2011 historic average Atlantic sturgeon capture rate is 1 fish per 56.7 for beam trawl samples and 1 fish per 253.5 for striped bass trawl tows.

This increase is not unexpected, as concluded by sturgeon researchers communicating with NMFS in annual reports and otherwise since 2010 that (K. Hattala, D. Fox; D. M. Fisher; J. Hightower; A. Spells; M. Balasik; W. Post; and D. Peterson, 2014. pers. comm.) as year-classes of mature adults, protected since the fishery closure in 1996, are now reported recruiting into the spawning populations. In 1997, just after implementation of the fishing moratorium, the index values calculated for Hudson River captures, increased over values observed prior to the closure (Figure 1).The annual index varied in a cyclic manner with peaks occurring approximately every three to five years. The exception occurred in 2012 when a dramatic increase occurred as the second highest observed value in the time series. Draft field sample data collected in 2013 and 2014 also suggest that continued recruitment success is occurring as catches are higher than those of 2012 (K. Hattala; 2014; pers. comm.).

- **Interaction of Atlantic Sturgeon Originating from other Listed DPSs**

The proposed action takes place in the Hudson River. However, in general, because Atlantic sturgeon are only migratory into marine water as older juveniles and subadults, they are concluded to not leave their natal river/estuary until they are older juveniles. Therefore early life stages (ELS), young of year, and smaller juvenile Atlantic sturgeon less than 500 mm in total length, are concluded to have originated from the Hudson River, belonging to the New York Bight (NYB) DPS. However, older juveniles (above 500 mm), sub-adults, and adult Atlantic sturgeon can be found throughout the marine range of the species. Therefore, these animals captured in the Hudson River and estuary would not be limited to just individuals

originating from the NYB DPS, and could potentially come from other DPSs in the mixed stock and could be taken in the proposed action.

To the extent that numbers proposed of Atlantic sturgeon captured would be changed in the new research, NMFS is required through the section 7 process of the ESA to make a new determination whether the changes in the proposed research would be likely to jeopardize the continued existence of any of the other Atlantic sturgeon DPS migrating into the action area affected by the action. The assumptions related to the estimates of capture interaction with other DPS's appear in Section 4.2.3.3 of this SEA and are taken from a NMFS technical memorandum describing the composition of Atlantic sturgeon originating from other DPSs of the species (Damon-Randall et al. 2013). This data is derived from genetic analysis of the animals captured in the New York Bight DPS and are expressed as the anticipated ratios (See Table 2 in Section 4.2.3.3.).

3.3.3. *NON-TARGET LISTED SPECIES AFFECTED UNDER NMFS AND USFWS JURISDICTION*

The listed non-target ESA listed species potentially appearing in the proposed action area, including sea turtles, whale species, and also protected marine mammals under the Marine Mammal Protection Act (MMPA), were discussed in prior NEPA documents (NMFS 2012a; 2011a; and 2006a). The respective Biological Opinions for these actions (NMFS 2012b; 2011b, & 2006b) concluded the research would not likely affect them. Thus, because NMFS concludes the identical research methods in the Proposed Action would continue not likely affect these species, they are no longer considered in this SEA.

3.3.4. *NON- LISTED BY-CATCH SPECIES AFFECTED*

Based on past experience, researchers would expect some non-listed, non-target species to be captured in fishing gear and all species have been typically returned unharmed with limited mortality. The applicants supplied results of netting bycatch of individual numbers of non-listed fish typical in the Hudson River and estuary action area (File No. 1547; NMFS 2006a). NMFS concludes that these same species would be typical of bycatch in the current modification. Additionally, researchers would return bycatch to the river. Base on prior netting over the last 10 years, the impacts of any incidental mortality of by-catch would not be long-term detrimental to the environment. Consequently, these effects will not be considered further in this SEA.

3.3.5. *AQUATIC NUSIANCE SPECIES*

The U.S. Geological Survey (USGS 2014) has identified aquatic nuisance species occurring in the coastal watersheds and near shore environments in the Hudson River action area which could potentially spread and threaten native biodiversity. The USGS Nonindigenous Aquatic Species (NAS) website (http://nas.er.usgs.gov) provides up-to-date information on new and existing occurrences of NAS. Because the netting and boating activities of researchers conducting Atlantic sturgeon or shortnose sturgeon research has minimized the spreading of vectors of NAS in past permits, the precautionary measures in the modified permit, such as following all state-mandated requirements and not reassigning gear to other watersheds until sanitized, rinsed, and air dried, would continue to be standard research protocol in the Proposed Action as in prior permits. Thus NMFS concludes the Permit Holder's actions in sturgeon research would continue to minimize the potential for spreading NAS in the environment.

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

This chapter represents the scientific and analytical basis for comparison of the direct, indirect, and cumulative effects of the alternatives of the permit modification's issuance. Regulations for implementing the provisions of NEPA require consideration of both the context and intensity of a proposed action (40 CFR Parts 1500-1508).

4.1 NO ACTION ALTERNATIVE

Under this No Action alternative, the take activities would continue as currently authorized in the existing Permit No. 16436 for Atlantic sturgeon until expiration on April 6, 2017; and in Permit No. 16439 for shortnose sturgeon until expiration of the permit on November 24, 2016. Based on the analyses in the 2012 EA (NMFS 2012a) and the 2011 EA (NMFS 2011a), NMFS determined that issuance of the permit and conduct of the associated research would not likely jeopardize the continued existence of either Atlantic sturgeon or shortnose sturgeon. However, this alternative would not provide exemptions to the ESA Section 9 for coincidental takes of either species in the same netting efforts when ESA regulatory authority lapsed for either species. This alternative would thus result in a requirement for discontinuing research efforts after the permitted take in either permit were reached; or after expiration of either permit. Additionally, other conservation efforts through meeting new research objectives would not be possible.

4.2 PREFERRED ALTERNATIVE: CONSOLIDATING EXISTING AND PROPOSING NEW TAKE OF BOTH ATLANTIC AND SHORTNOSE STURGEON UNDER PERMIT NO. 16436-01

Under this Proposed Alternative, consolidated take for either shortnose or Atlantic sturgeon would be authorized in Permit No. 16436-01, and when issued, the shortnose sturgeon permit (Permit 16439) would be terminated. Specifically, the anticipated impacts are summarized as follows: (1) Consolidating currently authorized take of shortnose and Atlantic sturgeon permitted for concurrent sampling in the Hudson River and Estuary; subsequently, the prior shortnose sturgeon Permit No. 16439 would be terminated; (2) Increasing the number of takes for procedures authorized for both shortnose and Atlantic sturgeon, reflecting more intensive sampling with revised objectives; (3) Adding a non-lethal laparoscopic procedure to biopsy liver samples associated with contaminant research; (4) Adding two rapid induced anesthetic procedures through high-rate MS-222 and electro-narcosis; (5) Increasing incidental (accidental) mortality to three animals of each species annually; and (6) Changing the start day for the annual reporting period for research beginning and ending on the calendar year, or January 1 to December 31.

Any impacts to the human environment of the Proposed Action alternative would primarily affect the target species, Atlantic sturgeon and shortnose sturgeon. Thus, there would be unlikely new impacts to the socioeconomic environment or risks to public health and safety, or to the physical environment in any way not previously analyzed in the original 2012 EA (NMFS 2012a) for Atlantic sturgeon research (File No. 16436) and the 2011 EA (NMFS 2011a) for shortnose sturgeon research (File No. 16439). Where changes occur within the biological environment in the proposed action not previously accounted for in prior actions, including the target and non-target species, this SEA documents the impacts and mitigations proposed to lessen the impacts of issuing the modification of research.

4.2.1. *Impacts of Consolidating the Take of Shortnose Sturgeon in Permit No. 16439 with the Take of Atlantic Sturgeon in the Modification of Permit No.16436-01.*

- ***Timing of Permit Modification Issuance***: NMFS considered the impacts of consolidating the takes of shortnose sturgeon previously authorized separately in the Hudson River in Permit No. 16439 with those authorized for Atlantic sturgeon in the same river system in Permit 16436. Because Permit No. 16439 is scheduled to expire on November 24, 2016, by consolidating the shortnose sturgeon taken with Atlantic sturgeon taken in Permit No. 16436-01 (expiring on April 5, 2017), the modification would effectively extend the take of shortnose sturgeon in Permit 16439 in the river for an additional 5 months. NMFS concludes, however, that this net extension of the authorized take would have a negligible long-term impact on the either sturgeon species' population.

- ***Impacts of Concurrent Sampling of Both Species in the Hudson River***:

Table 2 below illustrates the timeline for past concurrent research where both species have been taken in the Hudson River in the same netting since 2000. However, while research on ESA listed shortnose sturgeon during this period required an ESA permit because of the existing listed endangered status of the shortnose sturgeon, studies on Atlantic sturgeon were performed concurrently while it remained unlisted until 2012. The studies on both species however, were carried out using identical methods of capture and other research activities.

In 2000, the NYSDEC was authorized to take shortnose sturgeon in NMFS Permit No. 1226. The permit was also used in exploratory sampling to locate times and locations for optimal catches of juvenile Atlantic sturgeon prior to their age of emigration from the Hudson River estuary. In 2006, a new shortnose sturgeon research permit (No. 1547) was issued for more directed research objectives on the species; and in 2011 Permit No. 16439 was issued for shortnose sturgeon to reauthorize similar research. After Atlantic sturgeon were listed, the Permit Holder was issued a new scientific research permit for Atlantic sturgeon (No. 16436) in April 2012 to study Atlantic sturgeon.

Table 2: Timeline of concurrent research on shortnose and Atlantic sturgeon conducted by the NYSDEC in the Hudson River

	Shortnose Sturgeon		Atlantic Sturgeon*	
Years	Permit No.	No Taken	Permit No.	No Taken
2,000-2005	1226	254	None	562
2005-2006	1226	70	None	253
2007-2010	1547	289	None	832
2011-2012	16439	50	None	508
2013-Current	16439	81	16436	264

*Research on Atlantic sturgeon prior to April 5, 2012 did not require an ESA permit.

Although no animals have thus far been reported harmed in prior research by the Permit Holder, taking shortnose and Atlantic sturgeon in the same action using methods proposed in the modification, would continue to have potential for adversely affecting each species. Kahn and Mohead (NMFS 2010) documented that shortnose, Atlantic, Gulf and green sturgeon, react similarly to common stresses and threats from research methods used by the Permit

Holder. Thus, when taken in the same action, the impacts from research on shortnose and Atlantic sturgeon would be measured identically.

Consequently, NMFS concludes that the impacts on these species in the modified study can readily be analyzed independently in directed research within the same action. However, when existing permitted limits of either shortnose sturgeon or Atlantic sturgeon are met or exceeded, researchers would be required by permit conditions to cease studies on both species due to the possibility of taking either species concurrently.

4.2.2. Impacts of Authorizing Increased Take of Shortnose and Atlantic Sturgeon in the Hudson River.

The Permit Holder has requested taking greater numbers of shortnose and Atlantic sturgeon based on changes in research objectives. Over the remaining years of the permit, the total number of shortnose sturgeon authorized would increase from 5,160 to 5,546; and the total number of Atlantic sturgeon authorized would increase from 4,100 to 6,080. Increases in take of each species proposed was justified by the Permit Holder in the application (Appendix No. 3) by the need for documenting a "*Net Conservation Benefit*" in the construction of the Tappan Zee Bridge project (TapZee) as well as the installation of the Champlain Hudson Power Express power cable project (CHPE). Additionally, an anticipated increase in the Hudson River Atlantic sturgeon population has been evidenced by a recent juvenile cohort expansion in the Annual Hudson River Utility Trawl. A further need to expand the take numbers includes current regulatory restrictions of existing permits which limit the ability of researchers to sample both species adequately when fishing for both concurrently. Additional objectives related to sampling liver tissue with a minimally invasive procedure to determine the level of PCB and in Hudson River sturgeon would require adding electro-narcosis (EN) and MS-222 as optional surgical anesthesia procedures. Finally, there would be an anticipated increase in the incidental mortality of both species as a result of increased research activity.

The following summary, therefore, highlights the takes of both species proposed in the permit modification (See also Appendix No. 1 for proposed annual take sheet in Permit Modification No. 16436-01).

As indicated, the past level of take of both species in the action area has not led to a case of reported mortality or serious injury of Atlantic or shortnose sturgeon as a result of these research activities. However, the potential still exists for injury and mortality to occur due to the increased levels of research activities. Although a net increase in mortality of one shortnose and Atlantic sturgeon has been requested in the modification, the researchers would still be bound to conduct their research activities in accordance with the mitigating conditions in their original permits, reducing the likelihood of serious injury or mortality occurring.

Based on analysis in the original EA and Biological Opinion (NMFS 2012a), NMFS expects harassment due to research activities requested to be minimal and short-term. Further, the population and status of both species in the action area are well documented to be the healthiest of all river systems in their respective ranges. For these reasons, NMFS does not expect that increasing the numbers of take of shortnose and Atlantic sturgeon would significantly impact either of the populations in the Hudson River action area or their respective species range-wide.

4.2.2.2. ANTICIPATED NEGATIVE IMPACTS OF RESEARCH ACTIVITIES TO BOTH ATLANTIC AND SHORTNOSE STURGEON:

The risks to sturgeon from past proposed research activities are described in the original actions authorizing studies on Atlantic sturgeon (NMFS 2012a; NMFS 2012b) and shortnose sturgeon (NMFS 2011a, 2011b). These negative impacts from procedures, including capture, handling, marking, sonic tagging, anesthesia (low dose MS-222), gastric lavage, fin ray clipping and genetic tissue sampling, would continue to be mitigated by adhering to the research conditions outlined in the permit.

***Capture**:* Sturgeon captured in a gill net may be subject to stress and often with slight injury, such as reddened gills and scuffed from prolonged contact with nets. In extreme circumstances, death or serious injury, recognized by lethargic behavior or visible signs of external injuries may occur. Additionally, sturgeon have been observed with inflated swim bladders, having difficulty diving from the surface of the water when released after handling. However, sturgeon are very hardy and capture by gill net or trawl are typically non-injurious sturgeon, which recover rapidly after released (Kahn and Mohead, 2010; & Moser et. al, 2000).

***Handling/Restraint**:* Sturgeon may be subjected to additional stress when kept captive and handled prior to release.

***Marking**:* The insertion of Dart and PIT tags may cause additional stress to the sturgeon that after capture and handling. Both of these tagging methods puncture the skin of the fish and may potentially be a site of infection.

Implanting Sonic Tags Surgically: In general, adverse effects of these proposed internal tagging procedures of sonic transmitters could include pain, handling discomfort, hemorrhage at the site of incision, risk of infection from surgery, affected swimming ability, and/or abandonment of spawning runs. However, by using proper anesthesia, sterilized conditions, and proper surgical techniques described previously, these procedures would not be expected to have a significant impact on the normal behavior, reproduction, numbers, distribution or survival of shortnose sturgeon.

Anesthesia: The use of tricaine methanesulfonate (MS 222) to anesthetize fish is recommended in Moser et al. (2000) and Kahn and Mohead (2010) when sturgeon are surgically handled. Additionally, anesthesia is also used in other diet studies (Haley 1998 and Collins et al. 2006, 2008). There is a risk to individual fish during the induction to and recovery from anesthesia using MS 222, primarily from overdosing animals and leaving sturgeon to long under narcosis.

***Gastric Lavage*:** It has been reported that gastric lavage poses risk to sturgeon due to the morphology of sturgeon gut tract and physostomous swim bladder. Development of new techniques, using anesthesia and flexible tubing, now provide more safe and effective ways of obtaining diet samples from these fishes (Haley 1998; Collins et al. 2006, 2008).

Fin Ray Sampling: While conducting mark and recapture surveys of Atlantic and shortnose sturgeon, Collins et al. (2008) discovered that some secondary fin spines on larger mature sturgeon had enlarged abnormally when the sturgeon were recaptured. It was thought this

growth could potentially be detrimental to the affected sturgeons' health when removing the entire fin ray. At this point, their team decided to no longer remove entire fin spines from adult sturgeon, reasoning that this condition was related to slower growth in larger adult fish. Subsequently Peterson (pers. comm. 2009) reported his method of notching the fin-rays with few deleterious effects on re-sampled sturgeon examined.

Summary: Although sturgeon are sensitive to stress from impacts of research procedures, the prior methods of handling fish would be mitigated with the best management practices endorsed by NMFS (*Kahn and* Mohead 2010) outlined in the prior EAs and specified as conditions in the new permit modification; and, as such, these permit conditions should continue minimizing effects resulting from handling in the proposed modification.

4.2.3. Impacts of Authorizing New Research Procedures and Takes Not Considered in Prior Authorized Research

The impacts of and risks of newly proposed takes, including minimum invasive laparoscopy, biopsy, rapid induced anesthesia using both high dose MS-222 and electro-narcosis, and increased mortality, are highlighted in the following sections.

4.2.3.1. Laparoscopic Surgery and Tissue Biopsy

- ***Laparoscopic Surgery*:** Laparoscopic examinations have been used extensively in fisheries research (Murray 1998; Moccia et al. 1984; Ortenberger et al. 1996; and Stoskopf 1993) and refined for sturgeon work by Hernandez-Divers *et al*. (2004). Minimally invasive procedures, such as examining internal organs, determining sex, and performing biopsies, have been used by members of the researcher's staff on the Delaware River (Permit Nos. 14396 and 16431) and in South Carolina Rivers (Permit No. 1505 and 15677) for the past six years. These same staff members have also conducted training courses on the same procedures for other researchers. The Permit Holder now proposes to continue these same techniques with the same experienced researchers to sample liver and gonad tissues laparoscopically.

The laparoscopic procedures proposed would increase the risk of complications associated with the added stress of surgical procedures and the time under anesthesia. Because the sutures used to close the laparoscopy sites penetrate the body wall, they would also provide a route of possible infection. To combat these risks of surgery, the researchers would use sterile surgical technique and minimally invasive small incisions, minimizing the amount of suture necessary and decreasing the healing time. Finally, suture ties would be kept as short as possible and povidone iodine ointment would be applied to the sutures prior to recovery from anesthesia. This treatment would help prevent fungal growth on the sutures that could possibly infect the animal prior to healing of the incision wounds.

Furthermore, because each of the project staff performing laparoscopic examinations and obtaining biopsy samples would be trained professionals in fish pathology and veterinarian medicine, routinely having performed several hundred similar laparoscopic procedures on shortnose and Atlantic sturgeon without complication in other NMFS permitted activity, NMFS PR concludes that although hematological effects are associated with laparoscopy due to the small incisions and insertions of the laparoscope and taking the biopsy sample, the stress levels following tissue biopsy procedures would not significantly greater than those associated with handling and anesthesia. Therefore, we believe these procedures would have little

probability of killing or producing sub-lethal effects, as the healing process is rapid for this procedure.

- ***Tissue Biopsy:*** Liver and gonad tissue would be collected from three fish of each sturgeon species for two years for PCB and Dioxin analyses. Researchers performing biopsies have extensive experience in surgical biopsy of sturgeon tissues (performed more than 400 procedures on wild shortnose and captive Atlantic sturgeon; M. Matsche, pers. comm. 2014). Although the majority of fish assessed in previous studies required collection of only a single biopsy from the gonad for maturity assessment, two small studies (unpublished data) were conducted to determine the extent of tissue damage from multiple-sample liver biopsies using captive juvenile Atlantic sturgeon located at Horn Point, Maryland Laboratory. The first study was conducted in 2009 (M. Matsche; pers. comm.; 2014). Six fish were biopsied laparoscopically in June when water temperature was 26° C, and another four fish were biopsied in November when water temperature was 15° C. A total of 10 biopsies were collected along the length of the immature gonad of each fish (mean TL = 890 mm) so that the mesorchium or mesovarium was not damaged.

Hemorrhaging of the liver tissue was minimal, and ceased within a minute without intervention. One month following procedures, tissues appeared (grossly and histologically) to be regenerated with no obvious signs of tissue excavation or lesions. A second study was conducted using similar sized fish in May, 2010 to determine the safety of biopsying other internal organs, including the liver. Liver only was biopsied in four fish, while liver and gonad were biopsied in six fish (6-10 biopsies collected per organ per fish). Liver lobes in sturgeon are elongate, extending caudally in the coelom and are easily accessed laparoscopically without impacting surrounding organ or circulatory tissue (M. Matsche; pers. comm.; 2014). Biopsies were collected at the margins of the caudal end of the liver where vasculature is limited to hepatic sinusoids; hemorrhaging is minimal and the collection site is far enough removed to prevent rupture of the portal vein or gall bladder. All fish survived and tissues appeared to be regenerated, with no discernible lesions, after 1 month (M. Matsche, pers. comm. 2014). With the record of success on surrogate and wild animals biopsied by the researcher, listed as a Co-investigator on the permit, NMFS does not anticipate mortality or harmful injuries from wild sturgeon biopsies performed.

4.2.3.2. Impacts of Authorizing Rapid Surgical Anesthesia using MS-222 and Electro-narcosis (EN)

- ***Rapid Induced Anesthesia with MS-222 for Laparoscopic Surgery***: The proposed anesthesia protocol for laparoscopic surgery calls for rapid induction of surgical anesthesia on up to three shortnose sturgeon and three Atlantic sturgeon with a 250 mg/L buffer solution of MS-222 followed immediately by an 87.5 mg/L maintenance dose of MS-222 during surgery. This optional use of MS-222 would be limited to the animals selected for laparoscopic surgery and biopsy (a total of six fish) which are captured in brackish water.

The researcher's goal would be to rapidly achieve the desired plane of surgical anesthesia while minimizing stressful effects on animals during laparoscopic examination (Summerfelt and Smith 1990). Surgical anesthesia would be reached when the fish exhibits complete loss of equilibrium, decreased muscle tone and reaction to massive stimulation, while maintaining a depressed ventilation rate and regular heart rate (Ross and Ross 1999; Summerfelt and Smith 1990).

Invasive research activities can be stressful to fish, even if they are immobilized. Using an anesthetic thereby reduces the stress and risk of resulting mortality of these procedures (Iwama et al. 1989, Small 2003, Wagner et al. 2003, Coyle et al. 2004, Roubach et al. 2005, Wanner et al. 2007). Anesthetization, therefore, serves two purposes — it immobilizes the sturgeon while researchers perform very precise procedures, and numbs its stress response to pain during and after an invasive procedure when recovering.
The primary risks of inducing anesthesia on sturgeon are therefore typically overexposure or overdosing and the buildup of stress response hormones, such as cortisol. Overexposure occurs when sturgeon are left in an anesthetic bath longer than necessary to achieve narcosis. Overdosing takes place when the concentration of anesthetic is higher than the fish can tolerate. Both can cause lethal or sub-lethal effects. Further, the rate at which anesthesia is induced in fish is also important in minimizing stress. Marking and Meyer (1985) provided characteristics of an appropriate anesthetic protocol stating it should include both a rapid induction time (<5 minutes) and rapid recovery time (<10 minutes, faster for sedation). Using the proposed 250 mg/L MS-222 anesthetic protocol to induce surgical anesthesia, the Permit Holder's CI, Mark Matsche (2011 & 2013), reported average induction times of 2-5 minutes. Fish recovery times of 2-7 minutes were also reported by Matsche using this same protocol.

Further, the researcher's request for 250 mg/L MS-222 to induce surgical anesthesia is based on the lessening potential for inadvertent trauma to internal organs caused by laparoscopic instruments. When lower doses of MS-222 (i.e., 100, 150 & 200 mg/L) were used, researchers found shortnose and Atlantic sturgeon were not adequately anesthetized to nociceptive stimuli from the laparoscope, and reacted with tail flexions and body arching when cannulas were inserted into the coelom during laparoscopic examinations (Matsche, unpublished data). Such tail flexions and other body movements would greatly increase the risk of traumatic injury by instruments, which could potentially lead to impaired organ function, septicemia or hemorrhage. However, in tests using the prescribed surgical rapid anesthesia protocol, shortnose sturgeon remained stable and experienced no such reactions throughout laparoscopic examinations (Matsche 2011 & 2103).

Additionally, with regard to cortisol stress response, Matsche (2013) found cortisol hormone levels differ with respect to the level of anesthesia used for laparoscopic surgery. Specifically, Atlantic sturgeon anesthetized with a 100 mg/L concentration of MS-222 experienced elevated cortisol levels at 2 and 24 hours after surgery; however, no differences in cortisol and plasma chemistry were found between resting fish and fish undergoing laparoscopy after surgical anesthesia was induced (250 mg/L and maintained with an 87.5 mg/L dose of MS-222).

The researcher has demonstrated the proposed anesthesia protocol for laparoscopy— involving a rapid surgical anesthesia induction phase followed by a lower maintaining concentration— achieves a desired plane of surgical anesthesia limiting both the hormonal stress response and unpredictable reactions to nociceptive stimuli, each potentially harmful to sturgeon during a laparoscopy examination.

However, NMFS also recognizes the potential for lethal or sub-lethal effects on sturgeon while inducing surgical anesthesia at the prescribed rate, particularly if sturgeon are left unattended or are overexposed to the high concentration. Overexposure to such concentrations could be linked to a lack of experience or the researcher's inability to recognize the induction point of

surgical anesthesia. In interviews with other biologists performing similar anesthetic and laparoscopy protocols (D. Peterson, W. Post, and , J. Gibbons; *pers. comm.*; November 2009), proper training and experience in the procedure — knowing what to expect, as well as using proper equipment — were acknowledged as very important in developing proficiencies in the protocol.

To minimize exposure risks, the Permit Holder has added Mark Matsche as the CI on the permit to perform the high-dose anesthesia with MS-222. , who has routinely performed several hundred similar procedures without complication (Permit Nos. 1486, 1505, 1604, 14396, 15677 & 16431). Additionally, equipment used to induce surgical anesthesia would also include a heart monitor to assist researchers identifying the proper induction point of surgical anesthesia, thereby minimizing the exposure time of the animals to higher concentrations of MS-222 prior to transferring them to the lower maintenance dosage.

Therefore, NMFS believes the use of higher concentrations of the anesthetic compound MS-222, for short-term durations, and under constant observation by experienced researchers, is a safe procedure with manageable risks to the animals. Importantly, no other researchers than designated on the permit would be authorized to use the protocol without extensive, documented prior experience reported to NMFS-PR.

- ***Rapid Induced Anesthesia by Electro-narcosis (EN)***

The Permit Holder is requesting to anesthetize shortnose and Atlantic sturgeon when captured in freshwater locations. Initial evaluations comparing induced anesthesia using MS-222 and EN, yielded similar results of muscle relaxation and immobility (Kynard and Lonsdale, 1975 and Parker et al., 2002). However, a marked difference in the time taken to induce narcosis and also the time until complete recovery of shortnose sturgeon was observed when comparing the two methods. The electrical current immobilized the fish for surgery in an average of less than 10 seconds versus an average of 11 minutes for the MS-222. Moreover, the fish anesthetized with the direct non-pulsed electrical current recovered within a few seconds after the circuit was broken, swimming normally; whereas the drugged fish took five to seven minutes to fully recover from narcosis. The researchers continued to monitor fish for six weeks after the studies. No changes in swimming or feeding behavior were observed, and no burns, bruising, or mortalities were evident using the treatment. Moreover, the same researchers have been permitted by NMFS since 1984 (Permit Nos. 448, 726, 944, 1239, 1549, & 16549) to use EN and have reported zero mortality or any harmful effects associated with the procedure.

More recently, Balasik et al. (2013) reported on the physiological effects of both MS-222 and EN comparing the 1-and 24 h blood cortisol concentrations after surgery under EN or MS-222 anesthesia. Cortisol concentrations of EN and MS-222 did not differ significantly from those in untreated controls; but all three were significantly lower than the no-anesthetic group which received no anesthetic prior to surgical treatments. Further, there were no significant changes between 1- and 24-h blood cortisol concentrations in the treatments.

Thus, EN has several advantages compared to MS-222 including: potentially toxic chemicals are not ingested by animals, the chemicals are not released into the environment, anesthetic induction and recovery times are much less, and it is easier to make dose adjustments using the direct current. The risk associated with the procedure is over-applying the direct current causing cessation of opercula movement and involuntary respiration. However, as Parker et al. (2002) report, normal respiration returns almost immediately when direct current levels are

adjusted down to revive opercula movement. Additionally, electronarcosis may not be effective in brackish water, and there are no differences between EN and MS-222 in reducing 1- and 24-hr stress responses measured by cortisol concentrations (Balazik et al. 2013).

These results indicate electro-narcosis would not appear to cause long- term negative effects for sturgeon species greater than the best alternative of MS-222. NMFS thus recommends electronarcosis as a preferred method of inducing anesthesia where appropriate in freshwater locations to minimize stress in sturgeon involving surgical procedures or other procedures (e.g., gastric lavage) because it avoids the use of toxic chemicals and because rapid induction and recovery are virtually instantaneous.

4.2.3.3. IMPACTS OF INCREASED INCIDENTAL MORTALITY FROM RESEARCH PROCEDURES:

The Permit Holder has maintained a record of no mortality while engaged in other authorized research with shortnose sturgeon and Atlantic sturgeon in the same action on the Hudson River.

Although, recent changes in permit modifications issued by NMFS (Kahn and Mohead 2010) have resulted in significantly reduced research related mortality reported for shortnose sturgeon, there is still increased risk of direct and delayed mortality occurring under a heavier schedule of netting and takes requested through the modification.

Thus, NMFS believes the increased potential for serious injury, or mortality would result in a total of three unintended mortalities or serious harm annually for each species over the remainder of the permit. However, because the Hudson River populations of shortnose and Hudson River sturgeons are estimated as the largest stable stocks within each of their respective range, the anticipated impact of three sturgeon mortalities (or serious harm) on the population would be small.

If a greater incidence of mortality or serious injury should occur, researchers would be required to cease the study and consult with NMFS-PR to determine the cause of mortality and to discuss any remedial changes in research methods. The Permits Division could grant authorization to resume permitted activities based on review of the incident depending on the circumstances, or else, suspend further activities indefinitely.

4.2.3.4. RESEARCH IMPACTS ON ATLANTIC STURGEON ORIGINATING FROM OTHER DPSS

Because Atlantic sturgeon are known to occupy marine areas outside of their natal rivers (Damon-Randall, et al. 2013), there is potential for Atlantic sturgeon captured in the Hudson River to have originated from outside of the New York Bight DPS. The extent of coast-wide interactions of animals taken from other DPSs defined for Atlantic sturgeon is needed to determine whether the actual take authorized in research does not exceed the authorized take in permits. Thus, with the increased numbers proposed to be taken in the modification, increased impacts are possible for Atlantic sturgeon having migrated into the system.

Having no knowledge at the time of capture of genetic origins of captured animals, and limited resources and technology to conduct immediate genetic tests necessary for determining DPS origins, the numbers of animals captured from separate DPSs would not be known for some time afterwards. Therefore, NMFS, under the ESA, is required to make an interim estimate,

based on the most relevant information available estimating the numbers of animals from the five DPSs of Atlantic sturgeon which would be authorized to be taken from each of the DPSs. In this regard, the Biological Opinion (NMFS 2014) prepared for this modification, estimates the numbers of Atlantic sturgeon potentially occurring in the authorized catch from other DPSs. This estimate was made by applying the following assumptions taken from NMFS (2013) and Fox and King (unpublished data) to develop an appropriate estimate of the mixing of animals in catches.

- NMFS anticipates that juvenile Atlantic sturgeon captured in the Hudson River measuring less than 500 mm (TL) should be considered native to that DPS; we also anticipate the early life stages (ELS) to be native.
- Similarly, NMFS anticipates Atlantic sturgeon captured in the Hudson River measuring above 500 mm (TL), would be derived from a mixed stock originating from the New York Bight DPS (92%); the Gulf of Maine DPS (6%); and the Chesapeake Bay DPS (2%). All other DPSs would not be represented (0%).

Highlighted capture data (presented in Appendix 5) shows that 89% (or 5411) of the Atlantic sturgeon captured by the NYSDEC over the past several years, when targeting both juvenile and adult life stages in the Hudson River, exceeded 500 mm (TL). Therefore, based on the above assumptions by NMFS (NMFS 2013), these animals larger than 500 mm (TL) are concluded to be within the size range potentially migrating from other DPSs. The remaining 11% (or 669) captured, measuring less than 500mm (TL), are also assumed native to the New York Bight DPS; and are thus judged to be 100% from the New York Bight DPS for Atlantic sturgeon.

Table 2 below illustrates NMFS's estimate of the genetic origin of the total proposed number of Atlantic sturgeon (6,080) to be taken over the remaining years of the permit modification.

Table 2. Projected Allocation by DPS of the total 6,080 Atlantic sturgeon authorized to be taken in the remaining years of Permit No. 16436-01 within the Hudson River.

Size & No. of Atlantic Sturgeon Anticipated Captured in Modification		NY Bight	GOM	Chesapeake Bay	Carolina	South Atlantic
Size (mm)	Number Authorized					
< 500mm[1]	11% or 669	**100% or 669**	0%	0%	0%	0%
≥ 500mm[2]	89% or 5,411	**92% or 4,978**	**6% or 324**	2% 108	0%	0%

1. The 669 Atlantic sturgeon captured <500 mm are assumed to be natal to the NY Bight.
2. The 5,411 Atlantic sturgeon captured ≥500 mm are assumed to have potential for originating from other DPSs at the ratio stated.

4.3. CUMULATIVE IMPACTS ON THE TARGET SPECIES

4.3.1. *EFFECTS OF OTHER STURGEON RESEARCH PERMITS*

The potential exists for both shortnose and Atlantic sturgeon authorized as takes in the current proposal to be taken from the Hudson River and adjacent river systems. Though the shortnose sturgeon is sympatric with the Atlantic sturgeon throughout much of its range, it spends more time in freshwater where Atlantic sturgeon occupies more of its life cycle in the open ocean. In recent years, however, telemetry data and genetic analyses of both shortnose sturgeon and, to a greater extent, Atlantic sturgeon have demonstrated coastal migrations between adjacent river systems may be relatively common in some areas (K. Hattala; and D. Fox-Hudson River; M. Kieffer; and G. Wippelhauser/ G. Zydlewski,-Maine Rivers; & D. Peterson,-S.E. Rivers, pers. comm., 2013). Nevertheless, even if the proposed modification is able to target the same animals coming from different river systems or are taken by the same or other Permit Holders in the region, NMFS would not expect cumulative impacts since the impacts of research activities would be expected to dissipate within a day, as was previously discussed in the 2012 EA for the original action (NMFS 2012a).

Further, as described in Kahn and Mohead (NMFS 2010), reactions of Atlantic and shortnose sturgeon to common methods of research were documented to be comparable where each species reacts similarly to stresses and threats related to research. Thus NMFS believes that the impacts to either species from the activities of researchers, which would be mitigated with appropriate permit conditions, would not produce cumulative impacts to either species.

Scientific research conducted on shortnose and Atlantic sturgeon has been evaluated during numerous ESA section 10(a)(1)(A) consultations for issuing scientific research permits authorized by NMFS (See Appendix No. 4). Currently, there are 23 active scientific research permits, with 12 targeting wild Atlantic sturgeon and 11 targeting shortnose sturgeon populations with similar objectives as those proposed by the applicant. As reviewed in this SEA, these actions also include the original actions of Permit No. 16439, Permit No. 16436 and Permit No. 17095-01, authorizing shortnose and Atlantic sturgeon research within the proposed action area of the Hudson River. However, although the Atlantic and shortnose sturgeon permits authorized in the Hudson River in Permit No. 17095 would overlap the same action area, the respective researchers are required in the permit to coordinate their activities with one another, thereby limiting netting efforts at the same time, and thus limiting the potential cumulative impacts resulting from research.

The Biological Opinion issued for each of these the permits included the requirement for consideration of cumulative effects on the species. For each permit, the Biological Opinion concluded that its issuance, as conditioned, would not likely to produce cumulative impacts or jeopardize the continued existence of either species, individually or cumulatively.

4.3.2. *SUMMARY OF OTHER ACTIONS IN TERMS OF CUMULATIVE IMPACTS:*

According to NEPA (CEQ, Section 1508.7 Cumulative Impact) "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

As discussed in the 2012 EA for the original action (NMFS 2012a), the target sturgeon populations may be exposed to other human activities, including by-catch in fishing gear, poaching, ship strikes, water quality and habitat alteration, dams, existing NMFS research permits and other activities. Also, refer to the baseline section of the biological opinion produced during the ESA Section 7 consultation for this permit modification (NMFS 2014), which includes the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area.

4.4. CONCLUSIONS:

This SEA analysis appropriately focuses on the effects on individuals, populations, and species by consolidating and increasing the numbers and types of takes of both species in the modification (File 16436-01). It also considers the potential for cumulative impacts on both species from the total amount of research permits issued and the impacts caused by other actions on the species.

By consolidating the takes of either species in the same permit, the modification would offer conservation measures to the recovery of the species by offering less duplication of research effort as wells as creating more efficient reporting when documenting the takes and impacts of concurrent research. Permits are required to target both species, either concurrently or independently, because both species occupy the same habitat. However, since both species have similar responses to research threats, the cumulative impacts on either species would be similar. Hence NMFS finds no evidence that targeting both species in the same action would increase individual, population, species, or cumulative impacts.

However, there also exists the potential for adverse effects arising from increased research activity on shortnose sturgeon and Atlantic sturgeon in the river. Nevertheless, as indicated, these animals have been exposed to identical capture and research procedures by the Permit Holder for over 10 years in New York waters. Since permitting research by the Permit Holder of Atlantic sturgeon in 2012, the species has also been the subject of more intensive research. The research, however, has documented no mortality or serious injury during the two year period. While the level of research has been greater, some individual sturgeon have been recaptured more than once and have shown no evidence of permanent or long term impacts (chronic or sub-lethal) in their behavior, condition, or health as a result of research activities.

NMFS therefore believes that the proposed modifications as discussed in the Proposed Action would not have a significant cumulative impact on either the human or marine environment; nor would it likely jeopardize the continued existence of endangered shortnose or Atlantic sturgeon. And, as modified, NMFS believes the research would also not have a significant cumulative impact on non-target species encountered or on the physical environment in the proposed action area. There is no critical habitat designated for either target species; and should critical habitat be designated prior to the expiration of either permitted action, permitted activity affecting the habitat would be halted until Section 7 interagency consultation were re-initiated to determine potential impacts.

Overall, with exception of the incidental lethal mortality potentially experienced by the individual sturgeon in the research, the proposed action would not be expected to have more than short-term effects on endangered shortnose and Atlantic sturgeon. However, NMFS concludes that the incremental impacts of the action, when added to other past, present, and reasonably foreseeable future actions discussed here, would be minimal and not significant.

The data generated by the research activities would help determine the movement, sizes of populations, habitat use, and life history characteristics of shortnose and Atlantic sturgeon found in the Hudson River. This information would be vital in predicting impact of multiple construction projects taking place in the action area currently. Further, the research activities would be directed at determining the genetic origin of Atlantic sturgeon occurring in the catch in order to determine the interaction of separate DPSs of Atlantic sturgeon.

Thus, the research would provide crucial information, helping to manage and recover both of the targeted species and would outweigh any adverse impacts that may occur. In conclusion, the proposed action would not be expected to have any more than short-term effects on marine populations or species or other portions of the environment and would also not result in any cumulatively significant impacts.

CHAPTER 5 LIST OF PREPARERS AND AGENCIES CONSULTED

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Appendix No. 1.

Table 1a: Annual Take for Permit No. 16436-01

Research and Monitoring of Atlantic sturgeon in the Hudson River Estuary

Species	Life Stage	Proposed Take Numbers	Observe Collect Method	Proposed Take Activities	Details	Location
Atlantic Sturgeon	**Juvenile** <1000mm	540	Gill Net Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample	**NYSDEC Juvenile Abundance Survey** (Year 2-5)	Hudson River New York Bight DPS
Atlantic Sturgeon	**Juvenile** < 1000mm	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Lavage	**TZEE Zee Monitoring**: **(Gastric Lavage)** (Year 2-5)	Hudson River New York Bight DPS
Atlantic Sturgeon	**SubA/Adult** 1000>1300mm	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Lavage	**TZEE Zee Monitoring**: **(Gastric Lavage)** (Year 2-5)	Hudson River New York Bight DPS
Atlantic Sturgeon	**Juvenile** < 1000mm	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Sonic Tagging	**TZEE Monitoring**: **(Movement Tracking)** (Year 2-5)	Hudson River New York Bight DPS
Atlantic Sturgeon	**SubA/Adult** 1000>1300mm	320	Gill Net/ Trawl	Capture; Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample	**Adult/Sub-adult Spawning Stock Characteristics** (Year 2-5)	Hudson River New York Bight DPS
Atlantic Sturgeon	**SubA/Adult** 1000>1300mm	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Sonic Tagging	**Adult/Sub-adult Spawning Stock Characteristics (Movement Tracking for Tappan Zee Monitoring)** (Year 2, only)	Hudson River New York Bight DPS
Atlantic Sturgeon	**SubA/Adult** 1000>1300mm	50	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Sonic Tagging	**Adult/Sub-adult Spawning Stock Characteristics (Movement Tracking for Champlain Cable)** (Year 2-5)	Hudson River New York Bight DPS

Atlantic Sturgeon	**Juvenile (<1000mm)**	1,000	Gill Net/ Trawl	Capture; Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic tissue	**Juvenile Population Estimate** (Year 4-5)	Hudson River New York Bight DPS
Atlantic Sturgeon	**Juvenile (<1000mm)**	3	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Laparoscope/Biopsy	**Contaminant Study (Liver/Oocyte Biopsy)** (Any 2 Years)	Hudson River New York Bight DPS
Atlantic Sturgeon	**Juvenile (<1000mm)**	3	Gill Net/ Trawl	Incidental Mortality	**Incidental Mortality** (Year 2-5)	Hudson River New York Bight DPS

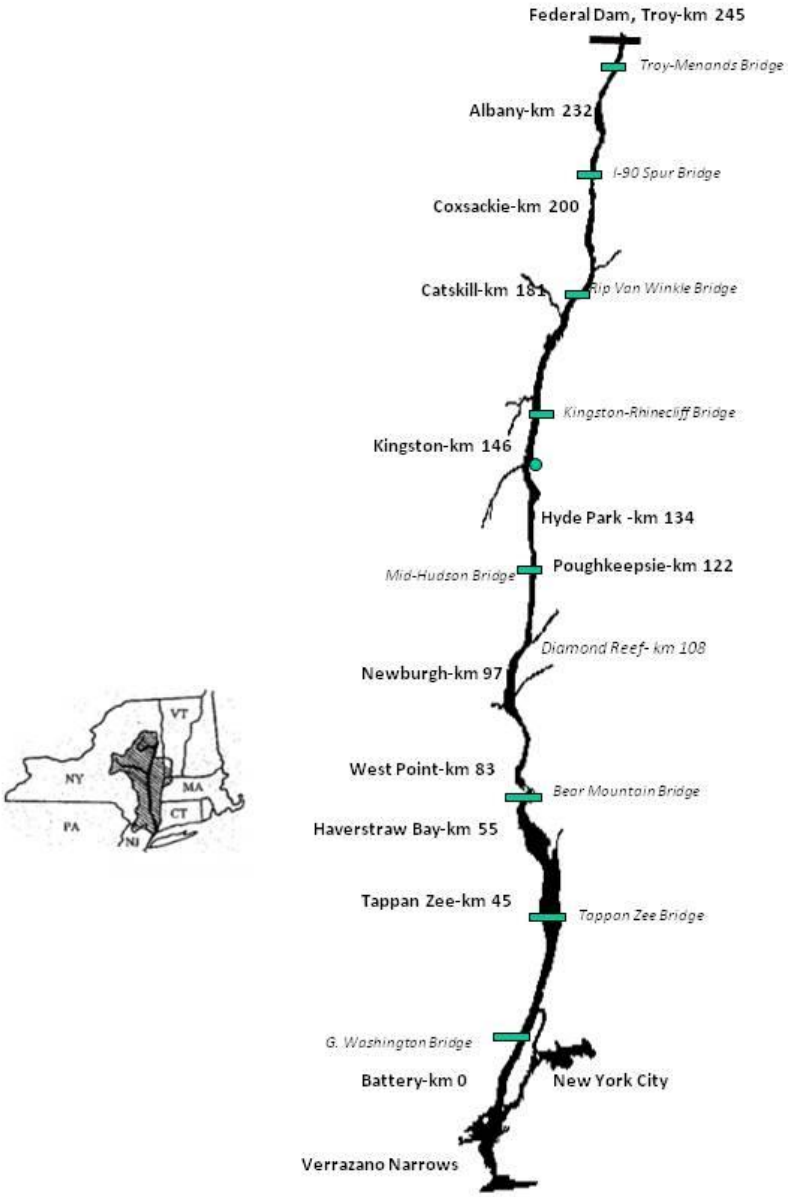
Table 1b: Annual Take for Permit No. 16436-01
Research and Monitoring of Shortnose Sturgeon in the Hudson River Estuary

Species	Life Stage	Annual Take	Observe Collect Method	Proposed Take Activities	Details	Location
Shortnose Sturgeon	**Adult/Sub-A Juveniles**	200	Gill Net Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample	**SNS Bycatch (NYSDEC Juvenile ATS Abundance Survey)** (Year 2-5)	Hudson River
Shortnose Sturgeon	**Adult/Sub-A**	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Lavage	**NYSDEC Monitoring**: **(Gastric Lavage)** (Year 2-3)	Hudson River
Shortnose Sturgeon	**Juvenile**	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Lavage	**Tappan Zee Monitoring**: **(Gastric Lavage)** (Year 2-3)	Hudson River

Shortnose Sturgeon	**Adult/SubA**	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Sonic Tagging	**TZEE SNS Sonic Tag (Movement/Habitat Use)** (Year 2-3)	Hudson River
Shortnose Sturgeon	**Juvenile**	30	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Sonic Tagging	**TZEE SNS Sonic Tag (Movement/Habitat Use)** (Year 2-3)	Hudson River
Shortnose Sturgeon	**Adult/SubA/ Juvenile**	200	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Fin Spine Clip	**NYSDEC Population/ Age Estimate Sampling (Year 4-5)**	Hudson River
Shortnose Sturgeon	**Adult/SubA/ Juvenile**	2,000	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample;	**NYSDEC Population/ Age Estimate Sampling (Year 4-5)**	Hudson River
Shortnose Sturgeon	**Adult/SubA**	3	Gill Net/ Trawl	Capture, Measure; Weigh; Photograph; PIT tag; Dart tag; Genetic sample; Anesthetize w/ EN or MS-222; Laparoscope/Biopsy	**NYSDEC Contaminant Study (Liver/Oocyte Biopsy)** (Any 2 Years)	Hudson River
Shortnose Sturgeon	Adult/SubA/ Juvenile	3	Gill Net/ Trawl	Incidental Mortality	**Incidental Mortality** (Year 2-5)	Hudson River

Life Stage: Atlantic sturgeon (TL):Adult=> 1,300mm; Sub-A=1000 - 1300 mm; Juvenile=< 1000mm
Life Stage : Shortnose sturgeon (TL): Adult = > 550 mm; Sub-A= 400 - 550 mm; Juvenile= < 400 mm.
NYSDEC = Ongoing research by the New York State Department of Environmental Conservation ;
TZEE =Tappan Zee Bridge Project;
CHPE =Champlain Hudson Power Express Project;

Appendix No. 2. Map of Hudson River and estuary.



Appendix No. 3:

NYSDEC's Application for Modification of Scientific Research Permit 16536 under the Endangered Species Act to consolidate collection of Atlantic sturgeon and shortnose sturgeon in the Hudson River Estuary

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The NYSDEC currently possesses two federal endangered species scientific research permits: # 16436 for Atlantic sturgeon and #16439 for shortnose sturgeon to cover agency collection of these species in Hudson River research programs. These programs primarily target Atlantic sturgeon and include an annual relative abundance survey for juvenile fish in late winter early spring, followed by an adult spawning stock survey in June. During the juvenile Atlantic survey, shortnose co-occur with young Atlantics and are captured as bycatch, hence the need for a permit for shortnose. NYSDEC initiated a small sonic tagging program for shortnose in 2012 with an expanded number of fish being tagged in 2013. Objectives of this program were to determine seasonal movement and habitat use of shortnose in comparison to juvenile Atlantics and to use the data to potentially design a mark /recapture program to estimate shortnose population size. Each of these programs is described in detail below.

New York proposes to continue its ongoing juvenile Atlantic sturgeon relative abundance and spawning stock surveys. New York also proposed to conduct two new directed studies: an acoustic telemetry survey of spawning adult Atlantic sturgeons, and acoustic tracking survey of Age 1 Atlantic strugeon for three years, followed by a large scale mark recapture population abundance estimate of juveniles for an additional two, and perhaps a third year in the next permit cycle.

In addition, two other projects are planned, both of which are to determine impacts of project activities on sturgeon in the river. The first project is in the final planning stages; it is to place a 1000 MW direct current electric transmission line down the axis of the Hudson River from Saugerties down to New York City, with the exception of Haverstraw Bay. The line will be routed through the Atlantic sturgeon spawning areas near Hyde Park and Newburgh Bay, along with being present in nursery areas for juvenile fish. The second project addresses impacts to sturgeon (both species) related to the construction of the replacement bridge over the Tappan Zee.

NYSDEC requests the following changes:

1) Combine both the Atlantic and shortnose sturgeon permits into one permit, with one reporting schedule. This will simplify tracking take numbers of both sturgeons and streamline the reporting process.

2) Once combined, change the permit / reporting period:

- Currently the Atlantic sturgeon permit cycle begins on April 6, Yr1 to Apr 5th, Yr2. These annual end and start dates fall in the middle of the juvenile sampling program. The shortnose permit cycle runs from Nov 24, Yr1 to Nov 23, Yr2 annually.
- We request that the permit / reporting period for the combined permit be changed to the calendar year Jan 1 to Dec 31st to simplify data summary and reporting requirements.

3) Increase the allowed take numbers:

NYSDEC requests an increase in the allowed take for all life stages of Atlantic and shortnose sturgeon to accomplish studies described for NYSDEC research studies and Tappan Zee Bridge construction and high voltage transmission line impact assessment/mitigation studies.

In addition, NYSDEC anticipates an increase in catches of juvenile Atlantic sturgeon in the annual survey in the near future. Catches are expected to increase dramatically based on the high 2012 catches in the Hudson River Generating (HRG) companies Fall Shoal Survey (FSS). The HRG permit number 17095-01, was recently modified in 2013 to allow an increase in take. In addition, bycatch of both species may occur when sampling for the annual DEC programs and the Tappan Zee projects are run simultaneously. The justification for the increases in take is described below.

ATLANTIC STURGEON

Abstract

Ongoing juvenile abundance sampling during early spring (March and April) has occurred for the Hudson River stock of Atlantic sturgeon since 2003. The goal had been to develop an annual relative abundance estimate. Although these data will provide a relative abundance indicator of juveniles, this indicator includes more than one age class of fish. To track true spawning success, a single age class of fish needs to be tracked annually. This additional juvenile work may require the use of smaller gill nets and/or a trawl (up to 15 m headrope) in the Hudson River. NYSDEC also samples a portion of the adult spawning stock. Fish are collected by large mesh drift gill nets in spring to early summer (late May through early July) in the spawning area. A specialized survey will also be conducted for the spawning stock to address a planned high voltage submarine cable in the spawning area.

Briefly, NYSDEC surveys include:

- Relative abundance survey for pre-migrant juvenile Atlantic sturgeon
- A study of dietary habits and a comparison of diets between co-occurring juvenile Atlantic sturgeon and shortnose sturgeon collected during the juvenile survey
- A small scale survey of adult Atlantic sturgeon to document annual biological characteristics of the spawning stock

Additional future studies are proposed to address data gaps, including:

- Using acoustic telemetry to evaluate the annual seasonal movement of juvenile (<1000 mm TL) down to Age-0/1 Atlantic sturgeon to determine extent of nursery habitat within the entire Hudson River Estuary
- The design of a large scale mark recapture study to estimate current population size of Age 0/1; last known estimate occurred in 1994

Impact assessment:

- Champlain- Hudson Power Express
  - Using acoustic telemetry to evaluate the movement of adult Atlantic sturgeon in the Hyde Park spawning area to evaluate the effects of a submarine high voltage transmission cable planned for the Hudson River Estuary
- Tappan Zee bridge replacement:
  - Determine dietary habits of Atlantic sturgeon (sub-adult and juvenile) and shortnose sturgeon (adult through juvenile). The diet study will be compared to benthic invertebrate sampling of substrates occurring in the Tappan Zee. This study is mitigation for the loss of 107 acres of habitat to be dredged for construction of the new bridge.
  - Using acoustic telemetry evaluate the movement of Atlantic sturgeon (sub-adult and juvenile)

and shortnose sturgeon (adult through juvenile) in the Tappan Zee, bounded by the G./ Washington Bridge and Stony Point NY. The work is to determine, if possible, effects on sturgeon by the construction activities (pile driving etc) on use of the near-field construction zone and the more far-field use of the Tappan Zee reach.

Purpose

We are applying for this permit to continue existing work on juvenile and adult Atlantic sturgeon, to estimate population size of Age 1 Atlantic sturgeon, and to provide a Net Conservation Benefit from impacts derived from construction of the Tappan Zee bridge replacement and placement of a 1000 MW high voltage DC current transmission line down the axis of the Hudson River.

Continuing studies include (information reported under Permits 1226 and 1547, 1547-1 and 1547-2 for bycatch of shortnose sturgeon):

- A juvenile relative abundance index for Atlantic sturgeon
- Diet studies of co-occurring Atlantic and shortnose sturgeons caught in the juvenile Atlantic sturgeon survey and as part of the Tappan Zee Bridge Replacement impact studies. Diets of sub-adult Atlantics will also be examined. Analyses of existing stomach samples are ongoing. Results will be further related to detailed mapping of bottom habitats where the fish are encountered
- Characterize spawning stock (age and size) of Atlantic sturgeon
- Conduct an acoustic telemetry survey of the Atlantic sturgeon in the near and far-field Tappan Zee reach to examine possible effects of construction of the replacement Tappan Zee Bridge
- Conduct an acoustic telemetry survey of the Atlantic sturgeon spawning area to examine possible effects of a high voltage transmission cable planned for burial along the axis of the estuary.
- Conduct an acoustic telemetry survey of Age-1 Atlantic sturgeon to determine timing and extent of their habitat use in the Hudson River.
- Based on result of the Age-1 telemetry survey, design and conduct a large scale mark-recapture survey to estimate current abundance of Age 1 Atlantic sturgeon in the Hudson River.
- Gain data on PCB contaminant loading in Atlantic sturgeon in the Hudson River.

Ongoing NYSDEC relative abundance of juvenile Atlantic sturgeon and diet studies

NYSDEC juvenile Atlantic sturgeon survey

In response to Amendment 1 to the Atlantic States Marine Fisheries Commission Atlantic sturgeon fishery management plan, NY was the first state to develop a juvenile abundance monitoring program. Beginning in 2003, NYSDEC, in cooperation with the USFWS Northeast Fishery Center- Lamar PA, worked on developing a relative abundance survey protocol for juvenile Atlantic sturgeon (Sweka et al. 2007). Juvenile Atlantics remain within the river from two to seven years prior to emigrating to the ocean for the sub-adult marine phase of their life. This survey samples this mixture of premigrant age classes in their known over-wintering habitat in Haverstraw Bay (Rk 56 to 64, Figure 1).

During exploratory efforts to develop this survey, sampling was distributed across four different bottom habitat types (soft deep, soft shallow, hard deep, hard shallow) in the lower section of the Hudson River in Newburgh and Haverstraw Bays (NYSDEC 2011). After 2005, sampling effort focused entirely within areas of deep soft substrate within Haverstraw Bay. Sampling in this habitat and location produced the most reliable catches of Atlantic sturgeon which increased the robustness of

our statistical analysis. Fish caught range in size from 300 to 1000 mm and are presumed to be ages one through seven.

Juvenile Atlantic sturgeon are captured by anchored monofilament gill nets. Each net is 61 m. long and 2.4m deep, set in groups of three. Each of the three nets is a different mesh size ranging from 7.6 cm to 12.7cm stretch mesh. Water temperatures during this survey often do not exceed 10C; Dissolved oxygen concentrations are high 9 to 13 mg/l (NYSDEC 2011). Nets are generally set for less than two hours. Captured fish are moved to a floating net pen and held for a maximum of one hour to await processing. Fish are measured, weighed, a genetic tissue sample taken, scanned for tags and marked with a Dart and Passive Integrated Transponder (PIT) tags if none are present.

We perform gastric lavage using the methods outlined by Collins et al. (2006, 2008) on a subset of captured fish to compare with stomach content samples taken from co-occurring shortnose sturgeon. Sample size will be similar to shortnose, approximately 40 juveniles annually for the five year permit period. Analysis of diet items will help identify inter-specific relationships between these two species regarding food preference and how preference may influence the spatial distribution of these species co-occurring in the same area. A greater understanding of sturgeon feeding preferences will also aid in the identification of critical habitats within the Hudson River Estuary. Linking food preferences with bottom types would allow us to narrow habitat use/needs, which are not fully understood. Some of these fish lavage samples are part of the mitigation study for the Tappan Zee Bridge replacement project (see below).

Expected increase in juvenile Atlantic sturgeon

In addition to the NYSDEC directed relative abundance survey for juveniles, the Hudson River Generating (HRG) companies' contractor Normandeau Associates, Inc. (NAI) conducts the Fall Shoal Survey (FSS). Although the FSS does not target sturgeon, juvenile Atlantics are taken as a bycatch and NYSDEC uses these data to calculate an ancillary index for tracking abundance. The NYSDEC index is calculated as total catch divided by the net-hours and further adjusted through covariance analyses for the location of the salt front relative to sampling. The FSS index is calculated using the number of fish caught divided by the number of trawl hauls from July through October each year.

Recent 2012 FSS sampling resulted in capture of a large number of juvenile ATS. The large catches were unusual in that sampling by the FSS beam trawl gear was limited in 2012 to September and October due to the delay by HRG/NAI to apply for a NMFS endangered species permit to include Atlantic sturgeon, along with additional permit-required water temperature and dissolve oxygen sampling restrictions. For annual comparison purposes, we re-calculated the entire time series to the September-October time period.

The abbreviated FSS beam trawl index indicated that an increase in abundance is occurring in the Hudson stock. This increase is not unexpected as year-classes of females, protected since the fishery closure in 1996, should now be recruiting into the spawning population. In 1997, just after implementation of the fishing moratorium, the index values increased over values observed prior to the closure (Table 1, Figure 2). The annual index varied in a cyclic manner with peaks occurring approximately every three to five years (Table 1, Figure 2). The exception occurred in 2012 with a dramatic jump to the second highest observed value in the time series. Draft field sample data collected in 2013 suggests continued recruitment success is occurring (catches are higher than in 2012).

The presence of young fish in the FSS was verified by length data (Table 2, Figure 3). Mean total length is low when peak abundance of young fish occurs. The length frequency suggests that most of the smaller fish (<300mm) grow quickly into the larger size range over a two year period. After three years, the number of fish from strong cohorts in trawl catches declines as fish grow to greater than 700

mm. This is most likely due to the ability of these large fish to avoid capture by the beam trawl, and / or a change in their distribution in the river.

Juvenile Atlantic sturgeon taken by the NYSDEC gill net survey are generally larger than those taken by the FSS (Table 3, Figure 3). Mean total length patterns during spring gill net sampling track closely to those in the beam trawl survey, with a one to two year lag (Figure 2). This pattern illustrates the transition of fish availability from the beam trawl survey to the gill net survey.

The FSS and gill net surveys complement each other. Because the FSS samples throughout the spawning and early life stage nursery areas, the first indication of year-class production shows up in this gear's data. However, because juvenile sturgeon grow quickly, the beam trawl tends to only sample them for one to two years (estimated Age-0 and Age-1). The gill net survey continues to sample and track the fish for an additional two to four years (Ages 1, 2 to 3+). There is some overlap in the size ranges. The combination of these two studies allows for the identification of successful year classes, and documentation of their transition through the juvenile stage.

We expect that the first observed increase in abundance in the FSS that occurred in 2012 will be picked up by the NYSDEC survey within approximately one to two years. Draft field data from the FSS indicates that the catches continue to remain high in 2013; catches in 2013 are higher than those in 2012.

In 2012, NYSDEC collected 261 juvenile Atlantics in six weeks of sampling. Although the species was listed part-way through the juvenile survey, we use the total annual catch as an example of what can be caught. We terminated the 2012 juvenile ATS survey two weeks early due to unusually warm weather that changed staff commitments to initiate other surveys. Had we not stopped, we probably would have caught more than 300 animals for the season. The 300 fish limit specified in our current permit will be exceeded in the near future. We will not be able to verify the expected increase in abundance of juvenile Atlantics without an increase in allowed take.

We request to change our current limit of 300 juvenile to annually capture, handle and tag up to 600 wild Hudson River juvenile Atlantic sturgeon of unknown sex over the next five years of this survey.

Based on our past experience, we do not expect to have any mortality but we would like to request one incidental mortality per year in case of a rare mortality event due to an unexpectedly severe entanglement in the net.

Juvenile Atlantic sturgeon surveys – co-occurrence of Shortnose sturgeon

During the juvenile Atlantic survey, shortnose occur as bycatch. In most years, shortnose make up approximately 30% of the annual survey catch. However, this percentage varies annually; in 2012 shortnose only made up 6% of the total sturgeon catch (Table 4).

The co-occurrence of these two species, juvenile Atlantics with adult/ sub-adult shortnose has stimulated interest in understanding the relationship between the two species. We initiated some work on food habits with the taking of stomach (lavage) samples from both species where they coexist in Haverstraw Bay. The goal is to determine if there is the potential for diet overlap and thus competition between the two species. NYSDEC is currently procuring a contractor to identify diet items in all samples.

In order to understand general use of Haverstraw Bay and other areas of the river, NYSDEC initiated a small preliminary sonic study by tagging 15 adult shortnose and 15 juvenile Atlantics (fish were tagged prior to the species being listed) in 2012. The objective of the sonic tagging is to understand the seasonal overlaps and/or habitat use of the two species and life stages. For 2013, we are in the process of capturing and sonic tagging 50 shortnose to expand on the 2012 work.

In 2012, it was difficult to obtain a sufficient number of shortnose to tag during the juvenile Atlantic survey without compromising the abundance survey's sample size objectives. Tagging fish involves not only obtaining sufficient numbers of shortnose but also fish of the correct body weight for tag size, along with enough time to properly handle fish for surgical application of the tag without compromising the health of other fish being held. We conducted an additional five days of sampling with a second crew to obtain additional shortnose to tag. During this sampling we caught 20 shortnose along with 15 juvenile Atlantics. This additional juvenile Atlantic take came from those allotted for the juvenile survey.

In 2013, we directed sampling on shortnose primarily in the lower Hudson (Haverstraw and Croton Bays), but conducted some exploratory sampling in the mid to upper estuary in search of smaller shortnose juveniles. This targeted sampling for shortnose has resulted in a total of 57 shortnose captured; 35 shortnose have been tagged thus far. Juvenile Atlantic sturgeon occur as incidental take when fishing for shortnose. Total take for juvenile Atlantic sturgeon for this portion of the 2013 -2014 permit year was 96 fish. We will continue to fish for shortnose this fall to put out the remaining sonic tags. Most likely we will continue to catch juvenile Atlantics as bycatch. This additional juvenile Atlantic take will likely compromise our ability to sample during the juvenile survey in early spring 2014.

Ongoing Adult Atlantic sturgeon Study

Dovel and Berggren (1983) and Van Eenennaam et al. (1996) provided information on spawning activities of Atlantic sturgeon in the Hudson River Estuary. Based on presence of spent or partially spent females, Dovel and Berggren (1983) reported that spawning occurred above the salt front in deep water from Croton Point (km 56) through Hyde Park (km 135). They suggested that spawning moved north as temperatures increased and the salt front moved upriver. Van Eenennaam et al. (1996) used oocyte development to identify females in spawning condition. They reported that spawning occurred from Hyde Park (km 135) through Catskill (km 180). Dovel and Berggren (1983) observed that mature males entered the river in April when water temperatures reached 6C. Females appeared several weeks later in May when temperatures reached 13C. Spawning continued into the summer months. Dovel and Berggren (1983) reported that females returned to the ocean after spawning whereas some males stayed for several months into early fall (October or November).

The NYSDEC has refined these past studies and has identified spawning areas through a large scale telemetry study of spawning adult Atlantic sturgeon (NYSDEC 2008). Since 2006, 51 pre-spawning adult fish were tagged with acoustic tags and tracked throughout the Hudson. Tags used varied annually: 10 Vemco tags (cooperating with other coastal researchers), 14 short term (several months) Lotek MAP and 27 five year (17 internal and 10 external) long term Lotek MAP tags. Tag life remains active for some of the long term tags up until 2013.

Tagged fish have been tracked annually since 2009 with mobile and remote receivers. Most all of the tags are Lotek Wireless MAP tags, chosen for their unique ability to allow pinpoint location of multiple tagged fish within close proximity to each other. Fish locations are then matched to another very detailed database of bottom habitats developed from extensive mapping of the deepwater (> 5 m) areas of the Hudson River Estuary. NYSDEC will continue to track the long term sonic tagged fish in the Hudson Estuary through the life of the long term sonic tags. A report detailing the sonic tracking work is in preparation.

The largest spawning area identified occurs near Hyde Park NY (River kilometer 133; extending from Dinsmore Point (Rk 139) south to Crum Elbow (Rk 128)(Figure 1). Two other smaller spawning areas occur near Catskill (Rk 180) and Diamond Reef (Rk 108). Pre-spawn staging areas for the Hyde Park area occur to the south from Crum Elbow down to Clinton Point (Rk 113) and for the Diamond Reef area in upper Newburgh Bay (Rk 100 to 106).

In addition to telemetry studies, we have conducted a small scale gill net survey of the adult spawning population to track annual changes in size and sex composition. Gill net sampling occurs in late May to early June. Fish are captured by large (41, 46, and 51 cm) stretch mesh anchor gill nets fished for usually less than one hour around slack tide. Once captured, fish are moved to a floating net pen prior to examination. Examination occurs on board the research vessel in a specially designed sling with flow through water system. Fish are examined for tags, measured, weighed, PIT and Dart tagged (if no other tags are present) and released.

A unique aspect of this spawning stock survey has been our ability to verify returning hatchery raised fish, released in the Hudson as Age 0 fish in 1994. In 2009 and 2010, two of these released fish matured (ages 15 and 16) and returned to the Hudson to spawn. Fish were verified by their coded wire tag and pelvic fin clip.

We plan to continue this work in the future and request the annual capture of mature fish.

Future adult acoustic study – impacts of a high voltage transmission line installation

By 2014, a 1000MW direct current high voltage transmission line, the Champlain Hudson Power Express, is planned to be installed in the river bottom along the axis of the Hudson River Estuary. As part of the mitigation for habitat disturbance, the applicant will set aside funds to assist the NYSDEC in conducting a fine scale mapping of adult Atlantic use in the Hyde Park spawning area. No data are available to determine the effects of a high voltage line, and its subsequent electro-magnetic field, on the behavior of spawning fish. To investigate these effects, 50 adult Atlantic sturgeon will be tagged with long term internal sonic tags and released. Fish are to be tagged either in pre-spawn locations or in the spawning area.

An array of receivers stationed at intervals throughout the spawning reach will track these fish in real time for both lateral and vertical movement (Figure 4). The objective is to determine if fish tend to avoid or are attracted to the area where the cable is installed. This study is still in the planning stage but is expected to include both pre and post operational stages of the line over a period of three to five years.

The current permit does allow the agency to surgically apply internal tags; we request this remain in the permit. However, we request an exemption to allowed fish to be sonic tagged in the spawning area for this project. From 2006 to 2008, NYSDEC internally tagged 50 adult Atlantic sturgeon in the Hyde Park reach; no fish abandoned the area after tagging. The effect of placing a high voltage transmission line through the Atlantic sturgeon spawning area is unknown. It is imperative that we examine if the behavior of fish that select this area to spawn is altered by the presence of this transmission cable. If fish are to be tagged pre-spawn far downriver of the Hyde Park reach it will not be known if these fish will actually select the test area to spawn. No data on sturgeon behavior will be gained for this and other additional proposed transmission lines (a second line permit application has already been submitted to the New York State Public Service Commission) and their effect on in-river use of this historic spawning area.

Adult Atlantic take

As indicated above in the juvenile Atlantic survey, the increase in the FSS indicates that recruitment is increasing in the Hudson stock. NYSDEC annually samples adult fish in the spring. In 2012, we have seen an increase in the number of adult fish taken in the limited sampling conducted. The NY moratorium has been in place since 1996 and coast-wide since 1998. We expect that juveniles protected by these moratoria have already begun to recruit to the spawning population and that we will see an increasing number of adult fish in the near future. Side-scan sonar work with Dr. D. Fox, University of Delaware, has confirmed the presence of many more fish than DEC samples (fish in

areas unavailable to gear). We will continue to pursue work of this nature with Dr. Fox, however, actual fish sampling needs to continue to provide the ground truth data on size and sex composition.

We request an increase in allowed take from 200 to 400 adult fish, to include 50 fish to be internally tagged with long term acoustic tags in the Hyde Park spawning area as described above.

Future Age -1 acoustic marking and population abundance study

Prior to 2012, early life stages of Atlantic sturgeon were rarely collected in the Hudson River Estuary. The Fall Shoals Survey (see above) has obtained the greatest number of Age -0 specimens (ASAAC 2009). These specimens indicate that the spring/summer nursery area for age zero fish is located from Newburgh Bay (km 90) through Kingston (km 146). This reach overlaps two spawning areas. Immature sturgeon (age 1+ and older) and older juveniles remain in the river several years before emigrating to the ocean (Dovel and Berggren 1983).

Two population estimates of immature Age-1 Atlantic sturgeon have been made for the Hudson River stock. Dovel and Berggren (1983) sampled and marked immature fish from 1976 through 1978. Estimates varied with data used, but ranged from 14,500 - 36,000 animals (mean of 25,000) for the 1976 year class at age one. In October of 1994, the NY State Department of Environmental Conservation stocked 4,929 marked Age-0 Atlantic sturgeon into the Hudson Estuary at Newburgh Bay. The U.S. Fish and Wildlife Service reared these fish from Hudson River parents. In 1995, Cornell University sample crews found 15 marked and 14 wild Atlantic sturgeon of the 1994 year class (Peterson et al. 2000). A simple Peterson population estimate from these data suggests that there were 9,529 Age-0 Atlantic sturgeon in the Estuary in 1994. Since 4,929 were stocked, 4,600 were of wild origin. This was a substantial decline from abundance of the 1976 year class. This low production year was just prior to NYSDEC closing the in-river fishery in 1996, followed by ASMFC implementing the coastal moratorium on Atlantic sturgeon in 1998 (ASMFC 1998).

There is a need for more up to date estimates of abundance that acknowledge and resolve estimate model assumptions about movement and mixing of these young fish in the river. Given inadequate knowledge about movement patterns, we feel that it is premature to attempt estimates of abundance without first understanding the extent of nursery habitat within the river. Abundance of Atlantic sturgeon is best measured at age-1 because emigration from the estuary starts at age-2. Current approaches to monitor annual juvenile abundance by sampling ≥age-2 are affected by unknown inter-annual variation in emigration rates. Unfortunately, obtaining adequate samples sizes of age-1 fish has been hampered to date by inadequate information about distribution and movement. This study has two objectives to address these data gaps:

- Identify movement and habitat use of age-1 Atlantic sturgeon within the Hudson River Estuary.
- Develop efficient sampling methodology for and estimates of abundance of age-1 Atlantic sturgeon within the Hudson River Estuary.

NYS proposes to use stratified and focused sampling and sonic telemetry to characterize distribution and movement of Age-1 fish within the estuary. We will estimate abundance of age-1 fish using a release recapture model appropriate to movement patterns observed with telemetry.

Fish will be captured by multi-mesh experimental gill nets or small trawls fished every week throughout the estuary during the ice-free period of the year. Captured fish will be handled and processed using standard procedures described below. Twenty-five age-1 Atlantic sturgeon will be sonic tagged in Year 1 and 50 fish per year in Years 2 and 3. Transmitter life will be based in the maximum tag size that the fish can carry.

Active tracking will take place using the same methods described for adult and juvenile fish. In addition, tags used will be picked up on the current array of stationary receivers deployed through-out the river (NYSDEC studies, Tappan Zee and TDI projects).

In addition to population work, an additional objective will be to describe sturgeon habitat use in the Hudson Estuary. Locations of tagged fish will be stored in a geo-database file and compared to data from recently completed NYSDEC bathymetry and substrate sediment type surveys for the entire estuary in water >4 m deep. These data are in a layered GIS-database and have already been used in preliminary characterizations of sturgeon (see juvenile abundance survey above). A shallow-water benthic mapping project for water ≤4 m is now underway. GIS-based maps are also available describing location of submerged aquatic vegetation throughout the estuary. NYS also maintains continuous water quality monitoring stations at six locations throughout the estuary. These stations monitor DO, pH, conductivity, turbidity, chlorophyll, water depth, and salinity; these data are available for comparisons with sturgeon habitat use.

All capture and release data will be transferred to the USFWS Atlantic Coast Sturgeon tagging database, ACT sonic tagging network and NMFS.

Age-1 population estimate: Once we have obtained knowledge about movement patterns, we will use this data to design a larger mark-recapture program to estimate abundance of age-1 fish in the river. The last estimate in 1994 was approximately 4,600 wild Age-1 fish. Since then NYSDEC's juvenile survey and the HRGC Fall shoals survey data (Figure 2) suggests that the moratorium is producing positive results. We propose to capture, mark and release up to 300 Age-1 Atlantic sturgeon annually for two to three years. Capture and handling method are the same as described above

Tappan Zee Bridge Replacement Net Conservation Benefit

The Tappan Zee Bridge replacement is one of the largest construction projects to occur on the Hudson River since the building of the first bridge in the 1950s. As part of the NYSDEC construction permit, the permittee will have to provide a Net Conservation Benefit (NCB) for endangered species (see Title 6, NY Code of Rules and Regulations, Part 182) as construction activities will impact both sturgeons. Major impacts include the loss of 139 acres of river bottom (dredging necessary for the construction) along with direct impacts to fish due to the noise from pile driving. The NCB has two components: a river bottom mapping project and two projects related specifically to fish.

The first fish project will be to internally tag both Atlantic and shortnose sturgeon to examine the effects of bridge construction activity, specifically pile driving, on their behavior. To accomplish this, 30 juveniles and 30 sub-adult Atlantic sturgeon, 30 juvenile and 30 adult shortnose sturgeon will be tagged with a LOTEK dual mode (MAP/ R Code) tag. The LOTEK MAP portion of the tag allows for pinpoint location of fish to understand both seasonal use of the river along with preference for particular bottom types (as determined from comparing fish location to bottom map types). The pinpoint locations will be determined during mobile tracking throughout the Tappan Zee – Haverstraw Bay reach. The R Code portion of the tag allows these fish to be picked up on remote receiver arrays located in the construction area as well as at five kilometers intervals south and north of the bridge replacement project from the George Washington Bridge, New York City, north to Stony Point, NY.

The arrays were designed to complement the mobile tracking effort to examine if the construction activities affected fish behavior. For example, pile driving production mode activities will drive over 1,000 support piles in the bottom of the river. The sound waves generated during pile driving can range higher than 207 decibels, enough to kill a fish. Lower sound levels (150 to 187 decibels) can affect behavior and /or cause physiological damage. It is unknown what level of effects will occur for sturgeon. The tagging is to help determine if the fish move away, perhaps from preferred feeding areas, from the noise and how far.

We now know, through sonic-tagging work conducted by SUNY Stonybrook, that a portion of sub-adult Atlantics that over-winter in New York coastal waters enter and spend the summer in the Hudson River (K. Dunton, SUNY Stonybrook, personal communication). Fish migrate into the river during the month of May, remain in the lower Haverstraw Bay-Tappan Zee complex throughout the summer, then leave by late October. What we seek to understand is what resources these sub-adult fish are using during their summer residence in the river. In addition, ongoing NYSDEC sonic tagging indicates that some juvenile Atlantics use this lower Hudson River, not only for over-wintering but for summer feeding as well. It is unknown the extent of impacts that may occur on these fish resulting from construction activities for the bridge

The second project will be to determine diet items of juvenile and sub-adult Atlantic sturgeon and juvenile and adult shortnose sturgeon that frequent the Tappan Zee. Up to 139 acres of river bottom will be destroyed by dredging a channel east to west across the river to allow access for construction vessels. The diet items will be related to benthic macro-invertebrate surveys conducted before and after construction of the bridge.

Contractors will perform the work of capturing and lavage of both species and will operate under the NYSDEC permit. All of the allowed activity required for the bridge (lavage and interlay tagging is currently allowed with the exception of lavaging sub-adult Atlantic sturgeon. We are requesting the addition of the capture and lavage of 30 sub-adult Atlantic sturgeon for this project,

SHORTNOSE STURGEON

Abstract

Studies proposed:

- Continue relative abundance survey for juvenile Atlantic sturgeon, where shortnose sturgeon are collected as incidental bycatch
- Determine dietary habits and compare to co-occurring juvenile Atlantic sturgeon and as part of the Tappan Zee Bridge replacement studies.
- Evaluate the annual seasonal movement of shortnose sturgeon using acoustic telemetry within the entire Hudson River Estuary from New York harbor to Troy New York.
- Conduct an acoustic telemetry survey of the Atlantic sturgeon in the near and far-field Tappan Zee reach to examine possible effects of construction of the Tappan Zee Bridge replacement
- Design a large scale mark recapture study to estimate current population size; last known estimate occurred in 1998
- Gain data on PCB contaminant loading in shortnose sturgeon in the Hudson River

Purpose

We are applying to continue existing work and to expand former population studies on shortnose sturgeon, and to provide a Net Conservation Benefit from impacts derived from construction of the Tappan Zee Bridge replacement.

Continuing studies include (conducted under Permits 1226 and 1547, 1547-1 and 1547-2):

- A juvenile relative abundance index for Atlantic sturgeon, where shortnose sturgeon are caught as incidental bycatch.
- Diet studies of co-occurring shortnose and Atlantic sturgeons caught in the juvenile Atlantic sturgeon survey. Analyses of stomach samples is ongoing but results will be further related to detailed mapping of bottom habitats where the fish are encountered.
- Determine detailed seasonal annual movement of shortnose sturgeon within the Estuary using acoustic telemetry.

- Based on result of the telemetry survey, design and conduct a large scale mark-recapture survey to estimate current abundance of shortnose sturgeon in the Hudson River Estuary.
- Conduct an acoustic telemetry survey of the shortnose sturgeon in the near and far-field Tappan Zee reach to examine possible effects of construction of the replacement Tappan Zee Bridge
- Analyze tissue samples for contaminants, with particular emphasis on PCBs.

Background

The shortnose sturgeon is listed under the Endangered Species Act and occurs along the East Coast of North America from the Saint John River, New Brunswick, Canada to the Indian River, Florida (NMFS, 1998). Shortnose sturgeon in the northern half of their range move within these river systems throughout their lives and utilize different discrete areas for spawning, summer feeding, and overwintering (Bukley and Kynard, 1985; Kieffer and Kynard, 1993; Kynard et. al, 2000). Bain et al. (1998) described in detail the habitats thought to be used by Hudson River shortnose sturgeon. Two important areas were 1) the wintering area used by many pre-spawning sturgeon in the vicinity of Kingston (River kilometer 143) and 2) the major spawning area near the northern extent of tidal water near the Troy dam (Rk 245).

The Hudson River population is likely the most robust of all US shortnose sturgeon populations (NMFS 2010). Early gill netting work estimated the shortnose sturgeon population in the Hudson River for the period 1976-1978 to be approximately 13,000 individuals using the Peterson model (Dovel, 1979). More recent work attempted to replicate this earlier sampling and estimated the population size of shortnose sturgeon in the Hudson River to be approximately 61,057 individuals (Bain et. al, 2000). This greater than 500% increase in population size led these authors to proclaim the shortnose sturgeon of the Hudson River as an endangered species recovery success.

The final recovery plan for the Shortnose sturgeon (*Acipenser brevirostrum*) (NMFS, 1998) provided a thorough review of the population status, biological characteristics and recovery plan for all shortnose sturgeon populations on the eastern coast of the United States. It also outlined steps necessary for the delisting of the shortnose sturgeon. Criteria 1.2.2 calls for the identification of critical habitat for the shortnose sturgeon. The first step necessary for this identification include field research (mark-recapture, telemetry, survey sampling, etc) to document shortnose sturgeon seasonal distribution and concentration areas. Data collected by this project will strengthen existing (conventional tagging) data on seasonal distribution and concentration areas.

Shortnose and juvenile Atlantic sturgeon co-occur in the southern portion of the Hudson River Estuary (Bain 1997, Dovel 1979, Haley et al. 1996). Resource (habitat/food) partitioning between these two species is not presently well understood. Haley (1998) conducted preliminary shortnose and juvenile Atlantic sturgeon diet comparisons on the Hudson; Collins et al. (2008, 2006) are conducting similar ongoing studies in South Carolina. We will perform similar comparisons to determine the degree of diet overlap in the two sturgeon species when they co-occur over the same bottom type. In addition, the food items consumed will be matched to data on benthic community structure and sediment from Strayer et al. (2006) and Maher and Cerrato (2004). With diet data, we can perform a “bottom-up” and “top-down” approaches to describe seasonal habitat uses of sturgeon, in terms of benthic criteria. This type of habitat study for sturgeon has not occurred in the past.

We propose a sequence of studies to meet some of the criteria described in the Recovery Plan: to identify critical habitat (Criteria 1.2.2) and to evaluate the Hudson’s population stability (Criteria 1.1.3).

Non-directed studies

Incidental bycatch in juvenile Atlantic sturgeon survey and diet studies

Shortnose sturgeon are caught as by-catch in New York's Atlantic sturgeon juvenile abundance monitoring survey (NYSDEC 2011). Since 2003, shortnose sturgeon caught in this survey, have been tagged and genetic samples taken. A subset of these fish have had gastric lavage performed to compare with stomach content samples taken from co-occurring Atlantic sturgeon. Analysis of diet items will help identify inter-specific relationships between these two species regarding food preference and how preference may influence the spatial distribution of these species co-occurring in the same area. A greater understanding of shortnose sturgeon feeding preferences will also aid in the identification of critical habitats within the Hudson River Estuary. Linking food preferences with bottom types would allow us to narrow habitat use/needs, which are not fully understood.

Sturgeon will be captured annually by gill net in the Haverstraw Bay of the Hudson River, handled, and marked with Dart and Passive Integrated Transponder (PIT) tags. Gastric lavage will be performed on equal numbers of both species using the methods outlined in Collins et al. (2008, 2006). The project will take place annually from March through April. The methodology for the juvenile abundance survey was developed in conjunction with the United States Fish and Wildlife Service in Lamar, PA. The joint project identified the most efficient locations and time to sample juvenile Atlantic sturgeon in the Hudson River (Sweka et al. 2007).

We expect to annually capture, handle and tag (PIT/dart) 150 wild Hudson River shortnose sturgeon of unknown sex per sampling year during the juvenile Atlantic sturgeon survey. Fish caught range from non-spawning adults, pre-spawn adult and large juveniles (NYSDEC 2011). Sizes captured in prior sampling have ranged from 404-773mm FL (Annual reports, permits #1226 and 1547) with the majority of shortnose sturgeon collected ranging from 500-700mm FL. While based on our past experience, we do not expect to have any mortality but we would like to request one incidental mortality per year in case of a rare mortality event due to an unexpectedly severe entanglement in the net. Should this mortality occur, tissues will be analyzed for PCB content.

During exploratory efforts to develop the juvenile survey, sampling was distributed across four different bottom habitat types (soft deep, soft shallow, hard deep, hard shallow). For the annual sampling, effort is focused entirely on the soft deep areas that produced the most reliable catches of Atlantic sturgeon to increase the robustness of our statistical analysis. These areas were also where the majority of shortnose sturgeon catch was concentrated. Our largest annual bycatch of shortnose sturgeon is about 88 individuals per year during the juvenile survey.

Acoustic marking study

NYSDEC will attempt to evaluate the annual seasonal movement of shortnose sturgeon using acoustic telemetry within the entire Hudson River Estuary from New York harbor to Troy New York. Work was initiated 2012 and continues in 2013.

Shortnose sturgeon are considered amphidromous in the Hudson River Estuary (Bemis and Kynard, 1997; Bain, 1997), utilizing both fresh and salt water for non-breeding related purposes within their natal river. The movement and habitat use of Hudson River shortnose sturgeon have been evaluated by tag and recapture methods (Dovel 1979; Bain et. al 1995; Bain et. al, 2000; Haley 1999). Bain et. al (1995, 1997, 2000) identified wintering juvenile habitat in Tappan Zee Bay (River kilometer 39-50), pre-spawning adult wintering habitat near Kingston (Rk 143), and a single spawning site at the head of tide near Troy (Rk 245) (Figure 1). Dovel suggested that spawning occurred over a greater spatial area; from Germantown (Rk139) to Coeymans (Rk 214) (Figure 1) (Dovel 1979) and Coeymans (Rk 214) to Troy (Rk 245) (Dovel et al. 1992).

While this considerable amount of work attempted to document movement of shortnose sturgeon, the discrepancies point to a poor understanding of the precise location of critical habitat areas (i.e. additional wintering areas for non-spawning adults and full delineation of the spawning habitat). If shortnose sturgeon are relisted as a result of NOAA's [five year] status review process, critical habitat will need to be designated. An acoustic tracking survey is the best available tool to aid in this task.

The poor understanding of habitat use and delineation could also have affected past population estimates. All mark-recapture models have a suite of assumptions that must be met to enable the researcher to reliably estimate population abundance. Among these assumptions is that all marked individuals mix well into the unmarked population and have the same probability of being recaptured. Using geographically limited marking and recapture sites when fish are spread out over a much larger area can easily lead to violating modeling assumptions and bring into question the reliability of the estimates made.

Estimates of population size by Bain et al (1998) were quite large - up to 61,000 individuals. This is a very large increase from earlier studies of the spawning population size of approximately 13,000 (and up to 30,000 fish if females spawn once every three years) (Dovel et al.1992). This dramatic increase took place over the short time period of only twenty years; unusual for such a long lived fish.

Woodland and Secor's (2007) study investigated the cause of this dramatic increase attributing it to better survival of young in the late 1970s and early 1980s due to improved water quality in the Albany spawning area. However they also concluded the population was comprised of only seven percent juveniles, a very low fraction of the total population.

These differing conclusions bring into question the true stability of the Hudson Stock – did a dramatic increase occur or not? Why is it there are so many adults and so few juveniles?

We propose acoustic tag marking study of shortnose sturgeon to evaluate use of the river over series of annual cycles. The results of this study will give us the necessary insight to design a well thought out sample design to determine population abundance.

Fish will be tagged with long term (up to 1.5 to three year) internal acoustic tags in known over-wintering, spawning and/or summering areas. Current mark-recaptures of tagged shortnose indicate that more than one pre-spawn aggregation area is present in the Hudson. The known historic pre-spawn aggregation occurs near Esopus Meadows (Rk 143), near Kingston NY. Recapture data indicate a second area occurs in the lower river in Haverstraw Bay (Rk 56). Fish may choose either area to over-winter before participating in one (or perhaps) more spawning events elsewhere in the river. We propose to tag approximately 100 individuals of various life stages per year over three years. Most (50) fish will be mature adults (> 550 mm TL) to define spawning area(s), and post spawn concentration areas. In addition, to understand use of the river by younger fish 30 sub-adults (400-550 mm TL) and 20 young juveniles (<400 mm TL) will be tagged.

Fish will be tagged with dual mode Lotek Wireless dual mode (MAP/ R Code) tags, chosen for their unique ability to allow pinpoint location of the tagged fish. These locations are then matched to another very detailed database of bottom habitats developed from extensive mapping of the deepwater (>20 ft) areas of the Hudson River Estuary. The secondary tag signal (R Code portion), will be picked up by remote receivers moored throughout the estuary.

Following tagging, fish will be tracked daily by a mobile tracking boat or through the use of an array of remote receivers placed at intervals throughout the river. Shortnose will also be tagged with an internal PIT tag and receive an external Dart tag with unique identification number. Tag legend has the contact information as the USFWS Atlantic Coast Sturgeon tagging database. This office manages a coast-wide tag recapture database and publishes periodic reports on recapture information. Recaptures may

come from recreational and commercial fishers or any number of fisheries monitoring programs that take place on the Hudson River or near-shore ocean.

Population abundance

Project Objective: Over three years determine population abundance of shortnose sturgeon in the Hudson River Estuary using standard mark-recapture techniques

Past population studies focused on tagging pre-spawning adults in one over-wintering area near Kingston NY. Fish would then be recaptured at their spawning area near Albany / Troy. These studies were simplistic in design and attempted to estimate only the spawning population size. Bain et al. (1998) marked fish in a small portion of the over-wintering areas and recaptured fish in an equally small area near Albany. Dovel et al. (1992), marked fish repeatedly as he followed them north to the Troy area. Dovel et al. (1992) results suggest that the spawning area was quite large spread over 45 kilometers in the upper estuary from Coeymans (Rk 200) to Troy (Rk 245).

These past studies did not account for fish using non-sampled over-wintering areas, interval spawning (every other or three year gaps) for females, or even perhaps other spawning areas as suggested by Dovel (1979). Based on the result of the acoustic tracking study described above, a mark recapture design will be developed to mark large numbers of fish, up to 2000 per year, for a series of two to three years. Potentially the design may be similar to previous studies, but will include marking and recapture areas not considered in previous studies. Details on this portion of the study will be developed further once the results of the annual tracking data are summarized.

Tappan Zee Bridge Replacement Net Conservation Benefit

As described above for Atlantic sturgeon, work on shortnose sturgeon is also included as part of the NCB projects related to the construction of the Tappan Zee Bridge replacement. Projects proposed follow similar lines as for Atlantic sturgeon: 30 adults and 30 juveniles will be tagged with internal acoustic tags; 30 of each to be lavaged for stomach contents.

Shortnose are frequently observed jumping in the Haverstaw Bay / Tappan Zee complex during the summer and fall. So the objectives are two-fold – to observe behavior in relation to construction activities of the bridge (pile driving) along with trying to understand the relationship of shortnose with the co-occurring Atlantics. The two species are found over-wintering in Haverstraw Bay. DEC's recent sonic tracking data indicate that some shortnose co-exist with Atlantics for most of the year in the lower river. Some move as far south as upper New York harbor. The traditional literature suggests that shortnose spend most of their life in the fresh-water portion, whereas our initial tracking data suggests otherwise. And again, species inter-actions are still not well understood. Some adult and sub-adult Shortnose spend their summers in the Tappan Zee complex – overlapping the same areas as subadult and some juvenile Atlantics. We still do not understand how they share the resources (food and space) available in this reach.

Lethal Take

A primary concern for an endangered species is the effect of contaminants on the well being of the species, yet very little is known of the contaminant loading these fish carry The intentional lethal take for this study will be to obtain up to 3 fish per year of either species to determine current PCB (poly-chlorinated biphenyls) loading of tissues and various internal organs. Currently the Hudson's major PCB contaminant source is being dredged from the source site near Fort Edwards NY, approximately 64 km north of Troy NY.

Take for Contaminant Analyses

We request the one-year lethal take of three (3) adult, sub-adult or juvenile shortnose sturgeon and three (3) juvenile Atlantic sturgeon be permitted from the Hudson River to augment Dr. Isaac Wirgin/Dr. Chris Chambers PCB toxicity studies of young life-stages of both sturgeons. They propose to analyze congener specific levels of PCBs and PCDD/Fs in livers and eggs of environmentally exposed shortnose sturgeon and in livers of juvenile Atlantic sturgeon from the Hudson River. We propose that these fish will be collected in March 2014 or 2015. Drs. Wirgin/Chamber's previous studies have demonstrated that young life stages of both sturgeons are highly sensitive and dose responsive to PCB126 and TCDD induced lethal and sublethal toxicities (Chambers et al. 2012). Furthermore, their studies have demonstrated that these early life-stage toxicities are likely mediated through activation of the aryl hydrocarbon receptor (AHR) pathway (Roy et al. 2011).

In newly proposed studies to the Hudson River Foundation and Hudson River PCBs Natural Resources Damages Assessment, these investigators hope to broaden the environmental relevance of their studies by evaluating toxicities of a PCB Aroclor mix in these sturgeons and in developing toxic equivalency factors (TEFs) in sturgeons for the four coplanar PCB congeners that bioaccumulate to the highest levels in Hudson River sturgeons. For the purposes of this requested permit modification, they propose to compare the threshold concentrations of PCBs that elicit toxicities in their controlled lab studies to the burdens of these contaminants that are found in the tissues of environmentally exposed sturgeons from the Hudson River. This objective requires that tissue concentrations of PCBs and PCDD/Fs in environmentally exposed sturgeons be quantified on a congener specific basis to allow for determination of their toxic equivalency quotients (TEQs) in tissue. To date, there is a total absence of congener specific PCB or PCDD/F data in shortnose sturgeon or Atlantic sturgeon from the Hudson River or any other east coast estuary.

Furthermore, NYSDEC Bureau of Habitat Fish Contaminants Unit will utilize the remaining portion of these fish (flesh and other organs), other than livers and eggs, for additional contaminant analyses for comparison to the results of Drs. Wirgin /Chambers and to historical concentrations in these sturgeon species.

The NMFS Final Recovery Plan for shortnose sturgeon discusses in detail the possible effects of contaminants. The SSSRT (2010) indicates that in the past 37 years only six shortnose sturgeon have been analyzed for PCB (total only) contaminant level from the Hudson. The lack of actual contaminant loads carried by these fish leave the effects open to speculation on the actual exposure of the species in the wild.

Capture, handling and tagging of Atlantic and Shortnose sturgeon

Capture: Sturgeon will be captured by monofilament gill nets. Net and mesh size used will be appropriately sized for life stage sought. In the juvenile Atlantic sturgeon survey mesh size will range up from 7.6 cm to 12.7cm stretch mesh; slightly larger mesh may be added when shortnose are targeted. During targeted adult Atlantic surveys, nets from 25.4 to 35.5, or as large as 43 cm, stretch mesh will be used. Early spring water temperatures in the river generally do not exceed 10C until late April and can get as warm as 20C by late May. As water temperatures rise, DO concentrations generally decline. If netting occurs beyond the late May period, detailed attention to combined water temperature / DO concentration will dictate decreasing soak times to minimize stress to animals. Nets will be fished for one to two hours depending on tide conditions and water temperature.

Handling/Restraint: Temporary holding prior to release will be in an in-river, boat side net pen measuring approximately 1.5m long x 1m x 1m deep OR in an onboard live well with circulating river water, with oxygen pumped in. Handling of fish will be kept to a minimum: fish will be taken from the net and placed in the net pen, quickly measured, weighed and tagged and immediately returned to the

water. Fish will be typically held in the net pen for less than 30 minutes and never for more than two hours.

Marking: Captured sturgeon will be measured to the nearest millimeter for both fork and total length. Sturgeon will be weighed to the nearest gram or kg (adult Atlantics) in a water soaked sling. Fish will be scanned for previous marks. If a fish is not marked, it will be tagged with a PIT tag (10mm) injected just below the skin anterior of the dorsal fin beside the first dorsal scute. A Dart tag will be inserted in the musculature at the base of the dorsal fin.

Anesthesia/Gastric Lavage/ Internal tag implant: Captured sturgeon will be placed in a tricaine methanesulfonate solution (MS 222; 150 mg/L). Fish will remain in solution for three to five minutes; time duration dictated by body weight of the individual. The fish will then be removed from solution and placed dorsally in a water soaked sling. Running, oxygenated water will be pumped over the gills while fish are being handled.

Gastric Lavage: A tube (polypropylene; 3.2 mm outside diameter, 2.4 mm inside diameter) connected to a garden sprayer will be inserted down the esophagus, past the pneumatic duct, through the alimentary canal and into the fish's stomach. This tubing diameter is recommended for sturgeons with total lengths of 350 to 1250 mm. The fish will then be held ventrally and water from a garden sprayer (3.8 L) will flush the fish's stomach into a 0.5 mm mesh sieve. Samples will be preserved in 95% ethyl alcohol. The process takes from four to six minutes. The number of sturgeon of each species sampled by lavage will depend on interval of catch, and total numbers caught.

Internal tag implant: Fish will be internally tagged with acoustic tags, based on program objectives described above. The total weight of the tag will not exceed two percent of the body weight of the fish. Fish will be placed upside down in a water –soaked sling after anesthetized using MS-222. The incision will be made with a sterile scalpel using the smallest cut possible to accommodate the tag. The incision will be sutured closed and treated with a povidone iodine solution. All anesthetized fish will be placed in a floating mesh pen alongside the boat to recover, then released back to the river (Collins et al. 2008, 2006; A. Rourke, SCDNR, personal communication).

Anticipated effects on animals (for both Atlantic and shortnose sturgeon)

The risks to sturgeon for the proposed programs occurs during five discrete activities: capture, handling, marking, anesthesia and gastric lavage. We will address the specific risks of each of these activities to both individuals and the population as a whole and then consider the cumulative impacts of all of these activities.

Capture: Sturgeon captured in a gill net may be subject to stress and slight injury. Sturgeon are very hardy and capture by gill net is considered a recommended method by a protocol for use published by NOAA (Moser et. al, 2000). Sturgeon that we have captured by the methods described above with the mitigation measures described below have resulted in the capture of no sturgeon that appeared lethargic or had any visible sign of external injury. Additionally, we have also not observed any fish with inflated swim bladders that have difficulty diving from the surface of the water, another sign of stress.

Handling/Restraint: Sturgeon may be subjected to additional stress when kept captive and handled before marking. The use of tricaine methanesulfonate (MS 222) to anesthetize fish is recommended in Moser et al. (2000) and has been used in other diet studies (Haley 1998 and Collins et al. 2008, 2006). There is a risk to individual fish during the application of anesthesia. Previous studies have reduced the risk of using MS 222 solutions in diet analysis studies and give clear recommendations for solution concentrations and recovery (Cited above). Sturgeon undergoing anesthesia will be handled with

gloves to reduce the transfer of MS 222 solutions to other fishes. There is no presumed threat to other sturgeon in the study or those not captured.

It was once thought that gastric lavage was a risky technique, due to the morphology of sturgeon gut tract and physostomous swim bladder. Development of new techniques, using anesthesia and flexible tubing, now provide safe and effective ways of obtaining diet samples from these fishes (Haley 1998; Collins et al. 2008, 2006). Effects from gastric lavage would be seen in individuals involved in the procedure.

Marking: The insertion of Dart and PIT tags may cause additional stress to the sturgeon that are captured and handled. Both of these tagging methods puncture the skin of the fish and may potentially be a site of infection. We have observed no such infection in recaptured sturgeon and we are not aware of any literature that provides evidence that these small wounds have caused infection in the past.

Each of these activities individually causes no externally visible sign of stress. The cumulative impact of all of these activities have also shown no visible signs of stress (i.e. inflated swim bladder) when we have completed the work in the past.

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Table 1. Incidental catch of juvenile Atlantic sturgeon in fishery independent sampling during the Hudson River Generators Fall Shoals Survey in the Hudson River Estuary.

			Fall Shoals Survery			
Year	N-trawls	N-fish	c/f*100 Jul-Oct	N-trawls	N-fish	c/f*100 Sep-Oct
1985	1247	94	7.54	59	776	7.60
1986	1302	160	12.29	87	818	10.64
1987	1288	141	10.95	44	648	6.79
1988	1277	117	9.16	40	649	6.16
1989	1271	52	4.09	20	638	3.13
1990	1265	6	0.47	2	628	0.32
1991	1269	10	0.79	4	635	0.63
1992	1263	11	0.87	6	633	0.95
1993	1258	7	0.56	4	744	0.54
1994	1262	16	1.27	9	677	1.33
1995	1271	15	1.18	9	643	1.40
1996	1214	8	0.66	4	607	0.66
1997	**1020**	**37**	**3.63**	**28**	**588**	**4.76**
1998	**1013**	**20**	**1.97**	**16**	**584**	**2.74**
1999	**969**	**16**	**1.65**	**12**	**511**	**2.35**
2000	**1003**	**4**	**0.40**	**2**	**472**	**0.42**
2001	**977**	**20**	**2.05**	**10**	**544**	**1.84**
2002	**1011**	**36**	**3.56**	**23**	**580**	**3.97**
2003	**1013**	**37**	**3.65**	**18**	**581**	**3.10**
2004	**1008**	**22**	**2.18**	**9**	**541**	**1.66**
2005	**1015**	**10**	**0.99**	**3**	**519**	**0.58**
2006	**1013**	**11**	**1.09**	**7**	**475**	**1.47**
2007	**1013**	**28**	**2.76**	**17**	**475**	**3.58**
2008	**1010**	**17**	**1.68**	**7**	**579**	**1.21**
2009	**1013**	**15**	**1.48**	**8**	**574**	**1.39**
2010	***930***	***19***	***2.04***	***11***	***396***	***2.77***
2011	***908***	***19***	***2.09***	***9***	***396***	***2.27***
2012	***476***	***48***	***10.09***	***48***	***476***	***10.09***

Bold = post moratorium
***Italics* = draft data (based on weekly field reports)**

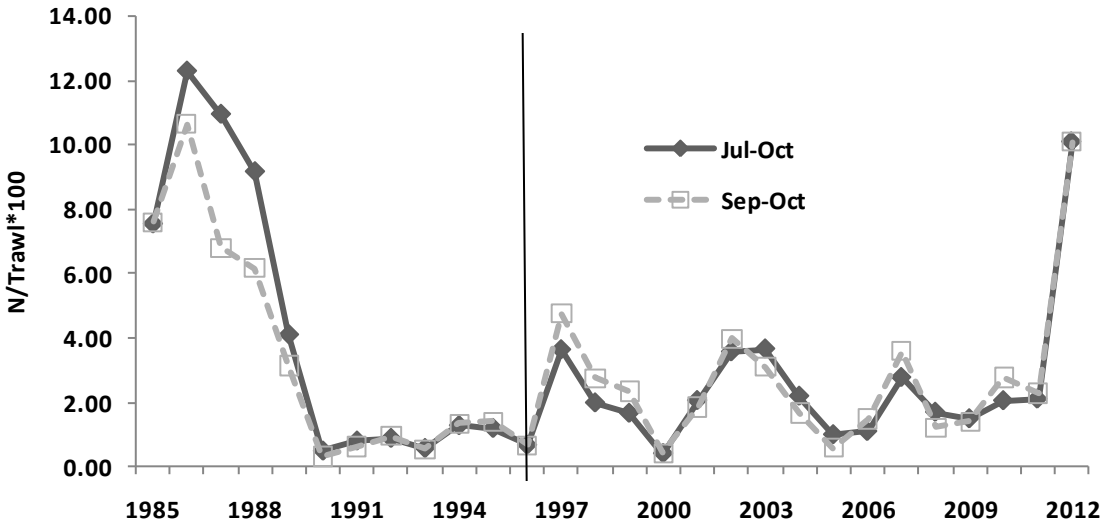

Figure 1 CPUE of juvenile Atlantic sturgeon collected by beam trawl in the Hudson River Power generators Fall Shoals Survey. Solid line= Jul-Oct index, dotted line = Sep Oct index. Vertical line indicates moratorium implementation in New York (1996).

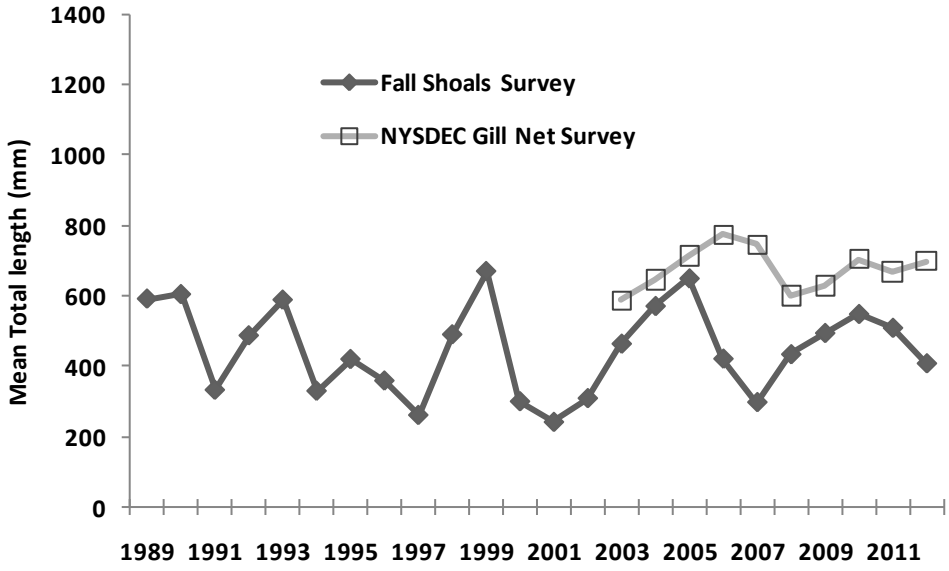

Figure 2 Mean total length (mm) of juvenile Atlantic sturgeon collected by beam trawl in the Hudson River Power generators Fall Shoals Survey and by gill net in the NYSDEC juvenile survey.

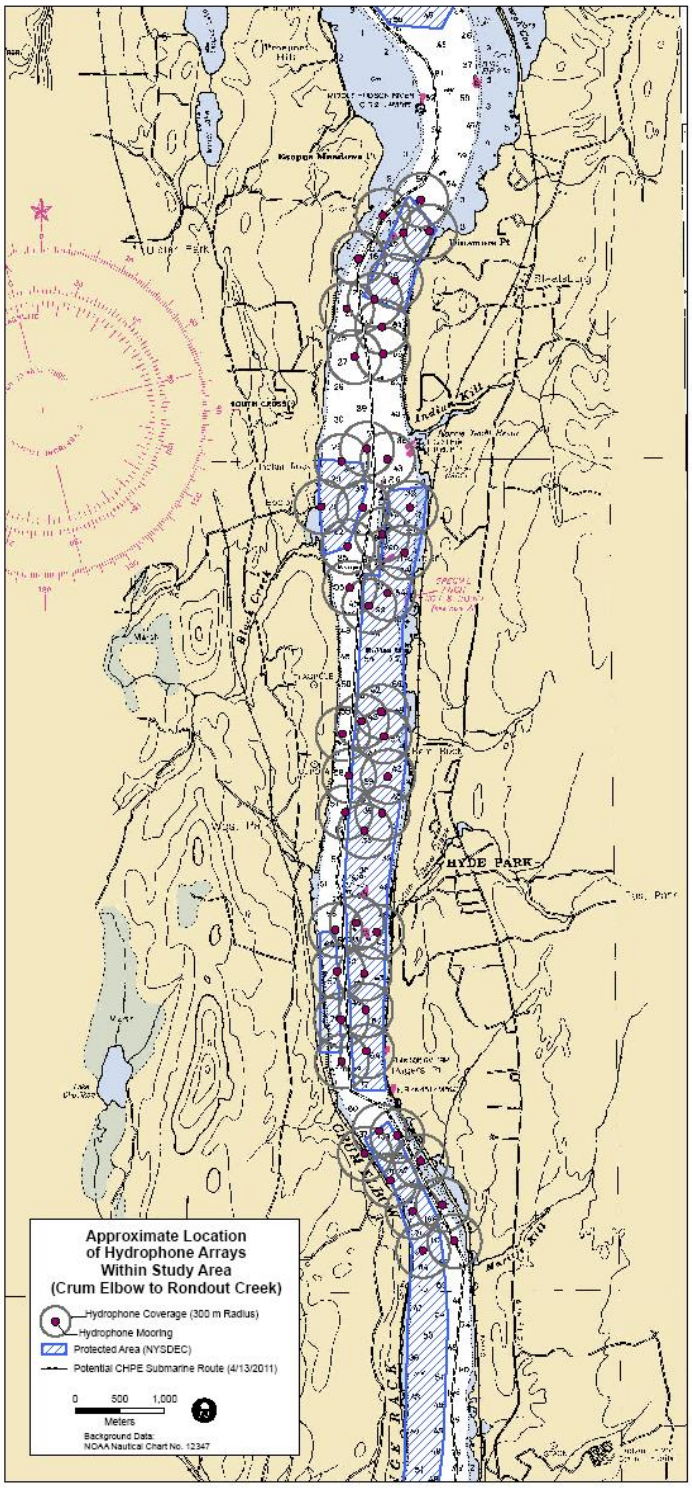

Figure 3 Proposed acoustic array to be used to location sonic tagged spawning Atlantic sturgeon to determine behavior of fish and possible impacts from operational effects of the Champlain-Hudson Power Express 1000MW electric current transmission line.

APPENDIX No. 4

Table 1: Listing of similar shortnose sturgeon ESA permits range-wide affecting the scope of the Proposed Action

14394 Expires: 9/30/14	Altamaha River and Estuary, GA	500 adult/juv. (1 lethal), 100 ELS	Capture, handle, weigh, measure, PIT tag, transmitter tag, tissue sample, anesthetize, laparoscopy, blood collection, fin ray section, collect ELS
15677 Expires: 5/31/2016	S. Carolina Rivers and Estuaries	154 adult/juv 100 ELS	Capture with gill & trammel net or trawl, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, laparoscopy, gonadal biopsy, blood sample; collect ELS
14759 Expires: 8/19/2015	North Carolina Rivers	70 adult/juv.	Capture, handle, weigh measure, Floy tag, PIT tag, genetic tissue sample; anesthetize acoustic tag
14176 Expires: 9/30/2015	Potomac River	30 adult/juv. 20 ELS	Capture, handle, weigh, measure, Floy PIT tag, genetic tissue sample; anesthetize w/ electronarcosis; & internal acoustic tag
14604 Expires: 4/19/2015	Delaware River and Estuary NJ & DE	1,000 adult/juv. (1 lethal), 300 ELS	Capture, handle, measure, weigh, Floy tag, PIT tag, tissue sample, anesthetize, ultrasonic tag, laparoscopy, blood collection, collect ELS
14396 Expires: 12/31/2014	Delaware River and Estuary NJ & DE	100 adult/juv	Capture, handle, measure, weigh, Floy tag, PIT tag, genetic tissue sample, anesthetize, and sonic tag
16439 Expires:10/31/2016	Hudson River (NYSDEC),	240 (yr 1-3) and 2,340 (yr4 5)	Capture, handle, weigh, measure, PIT & Carlin tag, genetic tissue sample, and gastric lavage
17095-01	Hudson River (Utility Trawl)	82- SNS adult/juv 40 SNS ELS 200 ATS adult/juv 40 ATS ELS	Non-lethal capture, handle, measure, weigh, scan for tags, PIT tag, Dart tag, photograph, tissue sample, and release
15614 Expires: 5/23/2016	Lower Conn. River & Estuary,	500 adult/juv (2 lethal); 300 ELS	Capture, handle, measure, weigh, PIT & Floy tag acoustic tag, gastric lavage, fin ray section, collect ELS
16549 Expires 4/1/2018	Upper Conn & GOM Rivers	300 adult/juv 150 ELS	Capture, handle, measure, weigh, PIT tag, genetic tissue sample, boroscope, anesthetize, and externally sonic tag
16306 Expires: 5/21/2017	Gulf of Maine, ME, & MA	500 adult/juv.; 30 ELS	Capture, handle, measure, weigh, tissue sample, PIT tag, acoustic tag, lavage, anesthetize, collect ELS

Note: Highlighted rows in darker blue designate active permits within the Proposed Action

Table 2: Listing of similar Atlantic sturgeon ESA permits range-wide affecting the scope of the Proposed Action

Permit Number	Location	Authorized Take	Research Activity
16526 Expires: 4/6/2017	Gulf of Maine Rivers and Coastal Areas	875 adult/juv, 300 ELS, 3 morts	Capture, handle, measure, weigh, PIT tag, foy/T-bar tag, tissue sample, internal tag, external tag, collect ELS, blood sample, apical spine sample, fin ray sample, anesthetize, boroscope, lavage.
16323 Expires: 4/6/2017	Connecticut River and Long Island Sound	200 adult/sub-adult	Capture, handle, weigh, measure, PIT tag, floy/T-bar tag, transmitter tag, tissue sample, anesthetize, fin ray section
16422 Expires: 4/6/2017	Coastal water between Long Island Sound and Delaware River	325 adult/sub-adult	Capture, handle, measure, weigh, PIT tag, dart tag, tissue sample, fin-ray section, anesthetize, blood collection, gill biopsy, external/PSAT tag, body tissue biopsy
16436 Expires: 4/6/2017	Hudson River and Estuary	1550 adult/juv 2 morts	Capture, handle, measure, weigh, dart tag, PIT tag, genetic tissue sample, anesthetize, gastric lavage, internal tag, external tag
16507 Expires: 4/6/2017	Delaware River and coastal waters	510 juv., 350 ELS	Capture, handle, weigh, measure, Floy tag, PIT tag, genetic tissue sample; anesthetize, fin ray section, gonad tissue sample, internal sonic tag, external satellite tag,
16431 Expires: 4/6/2017	Delaware River estuary	240 juv., 1 mort	Capture, handle, weigh, measure, Floy tag, PIT tag, genetic tissue sample, anesthetize, internal acoustic tag, gastric lavage, fin ray section
16438 Expires: 4/6/2017	Delaware River Estuary	284 juv., 50 ELS, 1 mort	Capture, handle, measure, weigh, Floy tag, PIT tag, tissue sample, anesthetize, internal sonic tag, laparoscopy, blood collection, gastric lavage, collect ELS
16547 Expires: 4/6/2017	Chesapeake Bay and its Tributaries, MD and VA	600 adult/juv., 25 ELS, 3 morts	Capture, handle, measure, weigh, Floy tag, PIT tag, genetic tissue sample, anesthetize, external sonic tag, internal sonic tag, fin ray section
16375 Expires: 4/6/2017	North Carolina Rivers and Albemarle Sound	200 adult/juv.	Capture, handle, weigh, measure, PIT tag, floy tag, genetic tissue sample, anesthetize, internal tag,
16442 Expires: 4/6/2017	South Carolina Rivers	400 adult/juv 50 ELS	Capture, handle, measure, weigh, PIT tag, dart tag, genetic tissue sample, anesthetize, internal acoustic tag, gonad biopsy, collect ELS
16482 Expires: 4/6/2017	Georgia Rivers and Coastal Waters	204 adult/sub-adt, 3270 juv., 250 ELS, 6 morts.	Capture, handle, measure, weigh, tissue sample, PIT tag, floy tag, anesthetize, internal/external acoustic tag, fin ray section, laparoscopy, internal acoustic tag, gonad biopsy, collect ELS
16508 Expires: 4/6/2017	Florida/Georgia Rivers	20 ATS St. Marys 20 ATS Nassau 20 ATS St. Johns	Capture, handle, measure, weigh, tissue sample, PIT tag, floy tag, external sonic tag

Note: Highlighted rows in dark blue designate active permits within the Proposed Action, including the original permit

APPENDIX No. 5

Hudson River Atlantic sturgeon catches by length bin (TL mm)

Non target sampling of ATS caught when fishing for SNS)

Bin	2012	2013	Total
281 - 300			0
301 - 320			0
321 - 340			0
341 - 360			0
361 - 380			0
381 - 400			0
401 - 420		1	1
421 - 440	1		1
441 - 460		2	2
461 - 480		2	2
481 - 500		1	1
501 - 520		3	3
521 - 540			0
541 - 560			0
561 - 580			0
581 - 600			0
601 - 620			0
621 - 640	2	1	3
641 - 660			0
661 - 680	2		2
681 - 700	2		2
701 - 720	1		1
721 - 740	3		3
741 - 760		1	1
761 - 780	2		2
781 - 800			0
801 - 820			0
821 - 840			0
841 - 860	1	1	2
861 - 880	1		1
881 - 900			0
901 - 920			0
921 - 940			0
941 - 960			0
961 - 980			0
981 - 1000			0
1001 - 1020			0
1021 - 1040			0
1041 - 1060			0
1061 - 1080			0
1081 - 1100			0
1101 - 1120			0
1121 - 1140		1	1
1141 - 1160			0
1161 - 1180			0
1181 - 1200			0
1201 - 1220			0
1221 - 1240			0
1241 - 1260			0
1261 - 1280			0
1281 - 1300			0
	15	13	28

Juvenile Atlantic gill net survey

Bin	2006	2007	2008	2009	2010	2011	2012	2013	Total
281 - 300		1					1		2
301 - 320			1	2			3		6
321 - 340			1	1			1		3
341 - 360	1		1				6		8
361 - 380			1	1			4	1	7
381 - 400							7	3	10
401 - 420			3				4	5	12
421 - 440			4		1	3	2	10	20
441 - 460			2	2		2	1	14	21
461 - 480			4			4		27	35
481 - 500		2	3	4		10		8	27
501 - 520		1	3	5		7		4	20
521 - 540	2	4		8	3	13	2	4	36
541 - 560			2	18	5	11	1	1	38
561 - 580	2	1	6	21	24	5	3	1	63
581 - 600	2		6	26	14	5	4		57
601 - 620		1	7	14	15	4	4		45
621 - 640	1		1	18	17	2	10		49
641 - 660	1		4	13	4	12	14	4	52
661 - 680		1	3	13	2	7	27	3	56
681 - 700	3	3	1	7	9	13	28	1	65
701 - 720	6		1	7	12	6	22	6	60
721 - 740	4	1	1	7	18	8	14	5	58
741 - 760	4	1	1	8	16	8	9	2	49
761 - 780	7	4	2	5	13	4	8	3	46
781 - 800	6	1	1	6	18	6	8	4	50
801 - 820	7	4	1	2	9	8	11	2	44
821 - 840	7	3		4	3	6	13	3	39
841 - 860	8	2	1		3	6	7	1	28
861 - 880	4	3	2		4		9	1	23
881 - 900	1	1			3	4	6		15
901 - 920	2	2	1		2	4	3		14
921 - 940	2		1	1			4		8
941 - 960	1	2	1		1		2	1	8
961 - 980	1	2		1	2	1	2		9
981 - 1000						1	1		2
1001 - 1020						1			1
1021 - 1040				1	1		1		3
1041 - 1060								1	1
1061 - 1080									0
1081 - 1100									0
1101 - 1120						1	1		2
1121 - 1140			1						1
1141 - 1160									0
1161 - 1180									0
1181 - 1200									0
1201 - 1220					1				1
1221 - 1240							1		1
1241 - 1260									0
1261 - 1280									0
1281 - 1300					1				1
	72	40	67	195	201	162	244	115	1096

Adult spawnign stock sampling

Bin	2006	2007	2008	2009	2010	2011	2012	2013	Total
1281 - 1300			1						0
1301 - 1320									0
1321 - 1340									0
1341 - 1360									0
1361 - 1380									0
1381 - 1400									0
1401 - 1420									0
1421 - 1440									0
1441 - 1460									0
1461 - 1480									0
1481 - 1500							1		1
1501 - 1520		1							1
1521 - 1540									0
1541 - 1560	2		1						3
1561 - 1580				1				1	2
1581 - 1600			2						2
1601 - 1620									0
1621 - 1640			3				1		4
1641 - 1660		1	2	1				1	5
1661 - 1680		1	2						3
1681 - 1700		1	1						2
1701 - 1720			1		2		2	1	6
1721 - 1740	3	1	2	5	1		4	1	17
1741 - 1760	1	1	2	1	1	3	2		11
1761 - 1780	1		2	2	1	1	1	3	11
1781 - 1800		1	4		2		2	1	10
1801 - 1820	2		2	1	4		6		15
1821 - 1840	1		3	1	2	1	4	1	13
1841 - 1860	2	1	3	3	2	4	7	2	24
1861 - 1880	3	2	2	5	1	1	4	1	19
1881 - 1900	2	2	1		1	1	4	5	16
1901 - 1920	2	1	4	2	4	4	4	4	25
1921 - 1940	1	1	7	2	2	2	4	2	21
1941 - 1960	3	1	2	2	3	3	6	2	22
1961 - 1980	3		3	2	1		1		10
1981 - 2000	2	2	5	4	5	2	4	1	25
2001 - 2020	1	2	2	2	3	2	1	1	14
2021 - 2040			1	3	1		2	1	8
2041 - 2060		1		1	4		2	1	9
2061 - 2080		1	2	1	4		3		11
2081 - 2100	3		2		2	1	1	4	13
2101 - 2120			3	2	1		2		8
2121 - 2140			1		4	1	1	1	8
2141 - 2160				1	4		1	1	7
2161 - 2180					1	1		1	3
2181 - 2200					2		1		3
2201 - 2220			3			1	1		5
2221 - 2240		2	2		1		1		6
2241 - 2260	2								2
2261 - 2280									0
2281 - 2300									0
2301 - 2320		1						1	2
2321 - 2340			1						1
2341 - 2360			1						1
2361 - 2380			1						1
2381 - 2400			1						1
2401 - 2420	1	1		1					3
2421 - 2440			1						1
2441 - 2460									0
2461 - 2480									0
2481 - 2500									0
2501 - 2520						1			1
	35	25	76	43	59	29	73	37	376