NOAA's National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Biological Opinion

Agency: Permits, Conservation and Education Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Activity Considered: Biological opinion on the issuance of a permit to evaluate shortnose sturgeon populations in the Hudson River (Number 16439) pursuant to section 10 (a)(1) of the Endangered Species Act of 1973

Consultation Conducted by: Endangered Species Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Approved by: for J. H Lecky

Date: NOV 21, 2011

Section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. 1531 *et seq.*) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" a listed species or critical habitat that has been designated for them, that agency is required to consult with either NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the listed resources that may be affected. For the action described in this document, the action agency is NMFS' Office of Protected Resources – Permits, Conservation and Education Division. The consulting agency is NMFS' Office of Protected Resources – Endangered Species Division.

This document represents NMFS' biological opinion (Opinion) on the effects of the proposed studies on endangered and threatened species and designated critical habitat, and has been prepared in accordance with section 7 of the ESA. This Opinion is based on our review of the Permits, Conservation and Education Division's draft Environmental Assessment, draft Permit Number 16439, the most current shortnose sturgeon stock assessment reports, recovery plan, scientific and technical reports from government agencies and the peer-reviewed literature, biological opinions on similar research, and other sources of information.

A complete administrative record for this consultation is on file at NMFS' Office of Protected Resources.

CONSULTATION HISTORY

On June 15, 2011, the NMFS Permits Division (PR1) requested consultation on its proposed issuance of a five-year permit 16439, which would allow the New York State Department of Environmental Conservation (NYSDEC) to conduct scientific research on shortnose sturgeon. On July 5, 2011, the NMFS Endangered Species Division (PR3) initiated consultation.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Permit No. 16439 would authorize research on shortnose sturgeon occurring for five years from the date of issuance. The research would characterize habitat use, population abundance, reproduction, juvenile recruitment, age and growth, temporal and spatial distributions, diet selectivity, and contaminant load of shortnose sturgeon captured from the Hudson River Estuary from New York Harbor to Troy Dam. Anchored and drift gill nets and trawl nets capturing up to 240 and 2,340 shortnose sturgeon would be used in year 1-3 and year 4-5, respectively (Table 1). Research activities would also include: measuring, weighing; tagging unmarked individuals with passive integrated transponder and Floy tags; and sampling tissue for genetic analysis. A first subset of fish would be anesthetized and tagged with acoustic transmitters; a second subset would have fin rays sampled for ageing; and a third subset of fish would have gastric contents lavaged for diet analysis, as well as have blood samples taken for contaminant testing. A total of two unintended mortalities per year for years 4-5 would be authorized over the life of the permit.

Table 1. Activities proposed under Permit No. 16439.

Life stage/sex*	Take Number	Purpose	Procedures	Study Period
Adult, sub-adult and juvenile	Up to 100 annually (50 adult, 30 sub-adult & 20 juveniles)	Monitor SNS acoustically habitat usage and movement	Capture, measure, weigh, scan for tag, PIT and Floy tag if untagged, genetic tissue sample, anesthesia, and **internal sonic tagging and tracking**	Years 1-3
Adult, juvenile	Up to 100 annually	Monitor SNS co-occurring with Atlantic sturgeon	Capture, measure, weigh, scan for tag, PIT and Floy tag if untagged, genetic and tissue sample	Years 1-5

Life stage/sex*	Take Number	Purpose	Procedures	Study Period
Adult/sub-adult	Up to 40 annually	Monitor SNS co-occurring with Atlantic sturgeon	Capture, measure, weigh, scan for tag, PIT and Floy tag if untagged, **tissue sample**, **blood sample** (for contaminant and genetic analysis), anesthesia, and **gastric lavage**	Years 1-5
Adult, sub-adult and juvenile	Up to 200 annually	Age and growth analysis	Capture, measure, weigh, scan for tag, PIT and Floy tag if untagged, genetic tissue sample, anesthesia, and **fin ray sample**	Years 4-5
Adult/sub-adult/juvenile	Up to 2,000 annually	Mark- recapture population estimate	**Capture**, measure, weigh, scan for tag, PIT and Floy tag if untagged, genetic tissue sample	Years 4-5
Adult/sub-adult/juvenile	Yrs. 1,2,3: 0 / Yr Yrs. 4,5: 2/Yr	Incidental mortality	**Lethal take**	Years 1-5

Years 1-3

Acoustic Tagging and Tracking Study

For the first three years of the permit, a stratified sampling and telemetry study would characterize the distribution and movement of adult and sub-adult shortnose sturgeon within the Hudson River Estuary. One field crew would focus on capturing and tagging up to 100 adult, sub-adult, and juvenile shortnose sturgeon, while a second crew would concentrate on tracking and maintaining stationary receivers deployed along the expanse of the Hudson River Estuary. Shortnose sturgeon would be captured by multi-mesh experimental gill nets and trawls fished every weekday throughout the estuary during the ice-free period of the year. Fish would be processed (measured, PIT-tagged, sampled, etc.) following standard protocols (Moser *et al*. 2000, Kahn and Mohead 2010). Only sturgeon in good condition would be anesthetized and surgically fitted with internal Lotek Wireless, Inc. acoustic tags (Dual mode MAP/r-code, specifications located at: http://www.lotek.com/ma-coded-acoustic-transmitters.htm) having a transmitter detection range of 0.6 -3.2 km depending on hydrological conditions.

Years 1-5

Juvenile Abundance Survey
During each year of the study from March through April, up to 100 shortnose sturgeon will be captured by gill net in the Haverstraw Bay of the Hudson River, handled, and marked with Floy and Passive Integrated Transponder (PIT) tags. Fish caught are anticipated to range from non-spawning adults, pre-spawn adults, and large juveniles ranging in length from 404-773mm FL with the majority of shortnose sturgeon collected ranging from 500-700mm FL. Netting efforts will be distributed across four different bottom habitat types (soft deep, soft shallow, hard deep, hard shallow) in the Haverstraw Bay where Atlantic sturgeon juveniles co-occur.

Gastric Lavage
A diet selectivity study is also proposed using gastric lavage to sample the gut contents of up to 40 additional sub-adult fish or juvenile shortnose sturgeon annually in the juvenile survey. Once the results from the diet selectivity study are analyzed, samples would be compared with those obtained from co-occurring Atlantic sturgeon. Additionally, concurrent sampling would take place measuring the availability of benthic food organisms with grab-samples of benthic organisms taken at random capture locations. These samples would be compared with extensive benthic habitat database gathered in the Hudson River Estuary over the last fifteen years.

Contaminant Study
The next proposed study in year one through five would address the effects of contaminant loading and uptake of various toxins in sturgeon. These levels are currently unknown. Forty blood samples would be collected from fish sampled in the above gastric lavage study and these samples would be included in the contaminant study. Genetic tissue samples would also be collected for the same purpose.

Age/Growth Study
During years one through five, research activities would include an age and growth study, taking fin-ray samples from up to 200 adult, sub-adult, and juvenile shortnose sturgeon. These fish would also be measured weighed, PIT tagged and Floy tagged if untagged, genetic tissue sampled, and anesthetized.

Years 4-5

Mark-recapture Population Estimate
During the fourth and fifth years of the study, PR1 proposes to authorize the capture of up to 2,000 shortnose sturgeon adult and sub-adults included in a mark–recapture tagging study. These results would aid in developing an accurate population estimate of the shortnose sturgeon adult and sub-adult segment in the Hudson River. The population model assumptions would be developed during years 1-3 based on the seasonal distribution of shortnose sturgeon found in the acoustic survey. All sturgeon in the mark-recapture study would be weighed, measured, PIT and external Floy tagged (if untagged), and genetic tissue sampled.

Capture

Adult, sub-adult and juvenile shortnose sturgeon would be captured using a standardized netting protocol (anchored and drift gill net sets and trawls) throughout the duration of the study.

Anchored Gill Netting

Sturgeon would be captured by multi-mesh experimental gill nets fished every weekday throughout the estuary during the ice-free period of the year. Additional sampling would occur at known or suspected shortnose sturgeon aggregation areas in late winter and spring to obtain fish for tagging. Gill nets will consist of monofilament nets varying between 5 cm (2-inch) and 18 cm (7-inch) stretched mesh, 61 m long by 2.4 m deep sampling for adult and sub-adult shortnose sturgeon. Anchored gill nets would be set parallel to the river flow to fish the bottom 1.8 m of the water column throughout the river. Nets would be set for 30 minutes to 4 hours per site, the duration of sets being dependant on location, time of year, temperature and dissolved oxygen (D.O.) regimes.

The net-set protocol that will be used is summarized in Table 2 below. Gill nets would be set in waters having at least the minimum D.O. concentration recommended, or 4.5 mg/L. Further, no netting activity would take place below 0°C or above 28°C. No surgical procedures would take place below 7°C or above 27°C. If water temperature is outside of these limits, sturgeon would only be measured, weighed, photographed, PIT and Floy tagged, and genetic tissue sampled before being recovered and released as soon as possible. The maximum net set duration would be 4 hours with nets tended during daylight hours. Other durations are also limited by water temperature ranges as indicated below.

Table 2. Summary of general netting conditions (all net sets must be attended in daylight hours).

Water Temperature (ºC)	Minimum D.O. Level (mg/L)	Maximum Net Set Duration (hr)
$0 \leq 15$	4.5	4
$15 \leq 25$	4.5	2
$25 \leq 27$	4.5	0.5
$27 \leq 28$*	4.5	0.5
>28	N.A.	Cease Netting

*Sturgeon must be released within 30 minutes of removal from capture net; only minimal procedures (e.g., PIT/Floy tagging, tissue sample, measuring, weighing) would be performed.

Drift Gill Netting

Drift gill nets would be drifted on the rising tide or in slack tide until just after high tide for durations of approximately thirty minutes to approximately two hours, depending on the location, swiftness of the tide, and netting condition protocols described above. Similarly, all drift net sets would be continuously tended because of the risk of gear entanglement or loss of gear resulting in ghost nets. Drift netting gear would be pulled immediately if it is obvious a sturgeon has been captured.

Drift gill nets would be set and marked with GPS coordinates beginning at early stage flood tide (slack) perpendicular to the prevailing tidal currents and tended closely by researchers until high

tide. To maximize chances of catching sturgeon, nets would be configured to make contact with the bottom and would have smaller mesh on the bottom two meters (McCord *et al.* 2007). Flat bottom locations free of snags near the freshwater-brackish water interface would be preferred location for each drift set.

Trawling

Dovel and Berggren (1983) found small trawls effective while collecting juvenile shortnose sturgeon in the Hudson River. Therefore, when the river is clear of ice, subject to environmental tolerances in Table 2, trawling would be performed year round. Specifications for proposed trawling gear in the Hudson River are provided in Table 3 below.

Table 3. Description of proposed trawling gear.

Trawl Dimension	***8 m Otter Trawl***	***9 m Otter Trawl***
Headrope (m)	7.93	9.14
Footrope (m)	7.93	9.14
Net body mesh (mm)	2.5 x 76.2	3 x 76.2
Codend mesh (mm)	2.5 x 76.2	3 x 76.2
Innerliner mesh (mm)	6	6

Trawls would be towed at a maximum speed of approximately 2.5 to 3.0 knots between 5 to 10 minutes. To lessen benthic disturbances, a GPS would be used to direct trawls so nets would not be towed over the same exact location more than once in a 24-hour period. Further, researchers would not attempt trawling areas with hard bottoms, vegetation, organic material, or woody debris to avoid snagging equipment. If a trawl were snagged on bottom substrate, researchers would attempt to untangle it immediately to reduce stress on captured animals. Further, if larger numbers of sturgeon were captured in a single trawl, researchers would take special precautions not to stress animals when transferring them onto the vessel by removing them from the cod end of the net.

General Handling

After removal from capture gear, sturgeon would be recovered in multiple boat-side net pens measuring approximately 100 cm long x 150 cm wide x 100 cm deep or in the live-well of the research vessel. When moved to onboard holding tanks, sturgeon would be immersed in a continuous stream of water supplied by a pump-hose assembly mounted over the side of the research vessel. Dissolved oxygen would be supplemented with compressed oxygen if necessary to ensure the concentration does not fall below 4.5mg/L. When readied for processing, sturgeon would initially be weighed, measured, fin clipped, scanned for PIT tags, tagged, and photographed. To minimize handling stress of sturgeon and removal their of protective slime coat, researchers would use latex gloves. Sturgeon would be weighed on a platform scale fitted with a small waterproof cushion attached to the surface of weighing platform. The sturgeon's total length would be measured on a standard measuring board and mouth width and interorbital width would be measured using calipers to confirm species (Kahn and Mohead 2010). The time required to complete routine, non-invasive methods would typically be less than one minute per fish.

Genetic Tissue Sampling

Genetic information would be obtained from tissue samples of sturgeon to help characterize the genetic "uniqueness" of the Hudson River. A small (1.0 cm^2) soft tissue sample would be collected from the trailing margin of soft tissue of one of the pectoral fins using sharp sterilized scissors. Tissue samples would be preserved in individually labeled vials containing 95% ethanol. The researcher has agreed to provide the genetic tissue samples for archival purposes to the NOAA/NOS tissue archive in Charleston, South Carolina, or to Co-investigators (CIs) identified in the permit. Proper certification, identity, chain of custody and shipping of samples would be maintained with tissue samples. Some of the genetic tissue samples would also be retained by the applicant for the proposed contaminant sampling.

PIT Tagging

Prior to PIT tagging, the entire dorsal surface of captured sturgeon would be scanned using a PIT tag reader to detect PIT tags of previously captured fish. All unmarked shortnose sturgeon (≥300 mm TL) would be tagged using 11.9 mm x 2.1 mm PIT tags injected using a 12 gauge needle at an angle of 60 to 80° in the dorsal musculature (left and just anterior to the dorsal fin). No fish would be double-tagged with PIT tags. The last step after injecting PIT tags would be to verify and record the PIT tag code with a tag reader. During the study, the rate of PIT tag retention would be documented and reported to NMFS in annual reports.

Floy Tagging

Shortnose sturgeon would be tagged with Floy tags (an external identifier tag) to document incidental recaptures by commercial or recreational fishermen and other researchers allowing collection of additional information useful for the assessment of the sturgeon population. In all captured shortnose sturgeon, Floy tags would be anchored in the dorsal fin musculature base and inserted forwardly and slightly downward from the left side to the right through the dorsal pterygiophores. After removing the injecting needle, the tag would be spun between the fingers and gently tugged to be certain it is locked in place. During the study, the rate of Floy tag retention would be documented and reported to NMFS in annual reports.

Acoustic Transmitters

During the first three years of the study, Lotek acoustic tags would be surgically implanted in a maximum of 100 fish (50 adult:≥ 550 mm; 30 sub-adult: 400-600mm and 20 juvenile :<400 mm) shortnose sturgeon. The Lotek acoustic tags would be Dual mode MAP/r-code tags having a transmitter detection range of 0.6 -3.2 km depending on hydrological conditions. Specifications of acoustic devices are located at: http://www.lotek.com/ma-coded-acoustic-transmitters.htm. The total weight of tags would not exceed 2 percent of the fish's total body weight of sturgeon determined to be in good condition.

Active tracking would take place on a research vessel fitted with a sonic receiver (Model 600 RT) and a laptop equipped with all necessary software, and dual hydrophones mounted to the stern. Tagged fish would be tracked constantly until dark during their first day at large.

Subsequent manual tracking would occur weekly throughout the range of estuary inhabited by the tagged fish. When located, a fish's exact location would be pinpointed using the dual hydrophone array while recording GPS locations. It would require approximately 5-6 days to cover the expected in-river range of tagged fish each week. Additional deployment of 13 remote receivers at regular intervals throughout the estuary would passively track acoustically tagged sturgeon.

Anesthesia for Implanting Acoustic Tags

Each sturgeon prepared for surgery would be anaesthetized using a solution of up to 150 mg/L of tricaine methane sulfonate (MS-222) buffered to neutral pH with sodium bicarbonate. A low volume pump would deliver the anesthetic over the fish's gills through a tube placed within the sturgeon's mouth until reaching proper state of anesthesia (i.e., loss of equilibrium, some reaction to touch stimuli, opercula movement). The anesthetic's induction and recovery time would vary between 5 and 9 minutes, but would be appropriate for shortnose sturgeon under the specific water temperature and oxygen conditions present (Fox *et al*. 2000, Kahn and Mohead 2010).

Surgery for Implanting Acoustic Tags

Just prior to a planned three minute surgical procedure, the tube supplying the anesthetic would be removed and the sturgeon would be placed on a moist surgery rack where respiration would be maintained by directing fresh ambient water pumped across the gills through the irrigation tube. The incision site for implanting the tag (located 40 to 60 mm anterior to the pelvic fins, although the specific location would vary with fish size) would be disinfected with povidone iodine (10 percent solution). A sterile surgical packet containing all surgical instruments and supplies would be used to make a 10 mm incision through which a sterilized transmitter would be inserted and the incision closed with interrupted sutures of 3-0 polydioxanone (PDS). The suture site would be treated with povidone iodine to prevent infection. Post-surgery fish would be held in a net pen and observed during recovery. Any fish not responding readily would be recovered further until showing signs of being able to swim away strongly. The fish would be released and a spotter would watch to make sure the fish remains down and fully recovered.

Blood Collection

Blood would be drawn from the caudal veins of 40 shortnose sturgeon annually for five years in an ongoing study determining PCB contaminant loads in the Hudson River shortnose sturgeon population. To draw blood, a hypodermic needle would be inserted perpendicular to the ventral midline at a point immediately caudal to the anal fin and the needle would then be slowly advanced while applying gentle negative pressure with the syringe until blood freely flows into the syringe. Once a blood sample is collected, direct pressure would be applied to the site of to ensure clotting and prevent further blood loss (Stoskopf 1993). Needle and syringe size, as well as blood volume collected, would be dependent on the fish size, as presented in Table 4 below.

Table 4. Needle and Syringe Sizes Proposed Based on Fish Weight

Weight (gr)	Sample Size (ml.)	Needle Size (Gauge x Length)	Syringe Size (ml.)
≤ 1000	2	22g x 5/8”	3
1000 - 2000	3	22g x 5/8”	3
> 2000	6	20g x 1”	6

Gastric Lavage

A diet study would be conducted using gastric lavage sampling sample gut contents on up to 40 fish annually for five years. Once the results from the diet selectivity are analyzed, samples would be compared with those obtained from co-occurring Atlantic sturgeon encountered during this study (to be covered under a separate permit application if the species is listed). Additionally, the current availability of benthic food organisms would also be surveyed with grab samples taken at random capture locations. Benthic data obtained would be compared with extensive habitat information already gathered for the Hudson River Estuary.

Sturgeon would be lavaged under a low dosage (50mg/L) of MS-222 anesthetic following Collins *et al*. (2008) and modified slightly. The modified procedure delivers water to the fish’s gut via a flexible tube. Once sturgeon are captured, they would be placed in a tricaine methanesulfonate solution (MS 222; 150 mg/L initial induction dose) remaining in solution for three to five minutes -the total time dictated by body weight of the individual. The fish would then be removed from solution and placed dorsally in a water soaked sling. 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. Diet samples would be taken from two out of every five fish caught and would be preserved in 95% ethyl alcohol. The entire process, including anesthetizing, would take from seven to eleven minutes (Collins *et al*. 2008). Fish would recover within a floating net pen alongside the boat prior to releasing them to the river.

Fin Ray Collection

Under light anesthesia (50 mg/L), shortnose sturgeon (200mm) would be collected for age and growth analyses in year four and five of the study. A small section (~1 cm^2 notch), of the leading pectoral fin ray would be collected on sampled fish using a hacksaw or bonesaw to make two parallel cuts across the leading pectoral fin-ray approximately 1cm deep and 1cm wide. The blade of the first cut would be positioned no closer than 0.5cm from the point of articulation of the flexible pectoral base to avoid an artery at this location (Rien and Beamesderfer 1994, Rossiter *et al*. 1995, Collins 1995, Collins and Smith 1996). The second cut would be made approximately 1cm distally (Everett *et al*. 2003, Fleming *et al*. 2003, Hurley *et al*. 2004, Hughes *et al*. 2005), where a pair of pliers would then be used to remove the fin ray section. The ray section would be placed in an envelope and allowed to air-dry for several days or weeks and later

it is cut into thin slices (usually about 0.5 to 2mm thickness) typically using a jeweler's saw or a double bladed saw (Stevenson and Secor 1999, Everett *et al.* 2003, Fleming *et al*. 2003, Hurley *et al*. 2004, Hughes *et al*. 2005, Johnson *et al.* 2005, Collins *et al.* 2008). The sections would then be mounted using any number of materials including clear glue, fingernail polish, cytosel, or thermoplastic cement. The annuli would then be read using stereoscopic readers. No other invasive procedures requiring anesthesia would be performed when sampling fin rays.

Unintentional Mortality or Harm of Shortnose Sturgeon

PR1 proposes to authorize two unintended mortalities or serious injury per year (during years 4-5 only) resulting from increased netting effort in those study years. This request was based on the cumulative stress anticipated from the volume of research activity required to sample sturgeon and meet the researcher's objectives. If a greater incidence of mortality or serious injury should occur, research would cease and the NMFS Office of Protected Resources would be contacted to determine the cause of mortality and to discuss any remedial changes in research methods during reinitiation of consultation.

Permit Conditions

The activities authorized herein must occur by the means, in the areas, and for the purposes set forth in the permit application, and as limited by the Terms and Conditions specified, including all attachments and appendices. Any permit noncompliance constitutes a violation and is grounds for permit modification, suspension, or revocation, and for enforcement action.

A. Duration of Permit

1. Personnel listed in Condition C.1 of this permit (hereinafter "Researchers") may conduct activities authorized by this permit for five years from the date of issuance. This permit expires on the date indicated and is non-renewable. This permit may be extended by the Director, NMFS Office of Protected Resources, pursuant to applicable regulations and the requirements of ESA.

2. Researchers must immediately stop permitted activities and the Permit Holder must contact the Chief, NMFS Permits, Conservation and Education Division (hereinafter "Permits Division") for written permission to resume:

   a. If serious injury or mortality[1] of protected species reaches that specified in Appendix 1. See Condition E.2 for reporting requirements.

   b. If authorized take[2] is exceeded, including accidental takes of protected species not listed in this permit. See Condition E.2 for reporting requirements.

[1] This permit allows for /unintentional serious injury and mortality caused by the presence or actions of researchers up to the limit of Appendix 1.

[2] Under the ESA, a take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to do any of the preceding.

3. The Permit Holder may possess samples taken, acquired, or imported under this permit after permit expiration without additional written authorization, provided the samples are maintained as specified in Attachment 1.

B. Number and Kind(s) of Protected Species, Location(s) and Manner of Taking

1. Appendix 1 outlines the number of shortnose sturgeon allowed to be taken, and the locations, manner, and time period in which they may be taken.

2. Researchers working under this permit may collect visual images (*i.e.*, any form of still photographs and motion pictures) as needed to document the permitted activities, provided the collection of such images does not result in takes of protected species.

3. The Permit Holder may use visual images collected under this permit, including those authorized in Appendix 1, in printed materials (including commercial or scientific publications) and presentations provided images are accompanied by a statement indicating that the activity depicted was conducted pursuant to Permit No. 16439. This statement must accompany all images in subsequent uses or sales.

4. Upon written request from the Permit Holder, approval for photography, filming, or audio recording activities not essential to achieving the objectives of the permitted activities, including allowing personnel not essential to the research (*e.g.*, a documentary film crew) to be present, may be granted by the Chief, Permits Division.

   a. Where such non-essential photography, filming, or recording activities are authorized they must not influence the conduct of permitted activities in any way or result in takes of protected species.
   b. Personnel authorized to accompany the Researchers during permitted activities for the purpose of non-essential photography, filming, or recording activities are not allowed to participate in the permitted activities.

   c. The Permit Holder and Researchers cannot require or accept compensation in return for allowing non-essential personnel to accompany Researchers to conduct non-essential photography, filming, or recording activities.

5. Researchers must comply with the following conditions related to the manner of taking:

   a. *Capturing*:

i. The Permit Holder must take all necessary precautions ensuring shortnose sturgeon are not harmed during capture, including use of appropriate net mesh size and twine preventing shutting gill opercula, restricting gill netting activities and decreasing the duration of net sets.

ii. Location (GPS), temperature, dissolved oxygen (D.O.), gear used for capture (e.g., mesh size, trawl, gill net), soak time, species captured, and any mortalities should be measured and recorded (at the depth fished) each time nets are set to ensure appropriate values according to the conditions below. This data must be made available to NMFS in annual reports or periodically upon request.

iii. Gill netting for shortnose sturgeon is regulated by environmental conditions appearing in Table 1 below. Nets must be tended during daylight hours.

Permit Table 1: Summary of environmental conditions regulating gillnetting.

Water Temperature (ºC)	Minimum D.O. Level (mg/L)	Maximum Net Set Duration (hr)
0 ≤ 15	4.5	4
15 ≤ 25	4.5	2
25 ≤ 27	4.5	0.5
27≤ 28*	4.5	0.5
>28	N.A.	Cease Netting

*Sturgeon must be released within 30 minutes of removal from capture net; only minimal procedures (e.g., PIT/Floy tagging, tissue sample, measuring, weighing) would be performed.

iv. At water temperatures > 27°C or < 7°C, authorized procedures must be non-invasive (e.g., PIT and Floy tag, measure, weigh, photograph, and genetic tissue clip).

v. Trawls may be towed at an average speed of 2.5 to 3 knots for up to 10 minutes; however, when anticipating larger catches, towing time should be minimized to limit overdue stress on catches.

vi. A depth sounder/global positioning system must be used to monitor trawling position to minimize disturbance of the substrate while trawling. Trawls may not cover the same area within a 24 hour period.

vii. If a net or trawl becomes snagged on bottom substrate or debris, it must be untangled immediately to reduce potential stress on captured animals.

viii. Drift gill nets may be used drifting on the rising tide or in slack tide until just after high tide for 30 minutes to two hours, depending on the location and swiftness of the tide.

ix. All drift net sets must be tended continuously due to the risk associated with gear entanglement, interaction with other protected species or the potential for loss of gear resulting in "ghost" nets. Also, drift nets must be pulled immediately if an obvious capture has been made.

b. *General Handling*:

i. After capture and during processing, sturgeon must be handled carefully and kept in water as much as possible to reduce stress.

ii. After removal from capture gear, researchers must hold sturgeon in floating net pens or in onboard live wells while shielding them from direct sunlight.

iii. To accommodate larger catches, if applicable, researchers must carry secondary net pen(s) in the research vessel; overcrowded fish must either be transferred to spare net pens, or released.

iv. While holding fish, they must always be contained in a sufficiently-sized live well with water (or floating net pen), and minimally crowded while transferring them.

v. Sturgeon overly stressed from capture must be resuscitated and/or allowed to recover inside a net pen or live well. At the discretion of the researcher, if the fish is recovered sufficiently, PIT tagging, Floy tagging, genetic tissue sampling, weighing, measuring and/or photographing may be done prior to release.

vi. When sturgeon are onboard the research vessel, flow-through holding tanks must allow for total replacement of water volume every 15 minutes. Backup oxygenation of holding tanks with compressed oxygen is also necessary to ensure D.O. levels remain adequate in the live well of the vessel.

vii. The total handling time of sturgeon while onboard must not exceed 20 minutes, unless fish have not recovered from anesthesia or stressed condition.

viii. The total holding time of shortnose sturgeon after removal from capture gear until they are returned to the water, must not exceed

two hours, except when water temperatures > 27°C where holding time must be reduced to 30 minutes after removal from the net.

ix. During onboard handling, sturgeon must be supported using a sling or net; and handling should be minimized throughout the procedure.

x. Smooth rubber gloves should be worn when handling sturgeon and bycatch to reduce skin abrasion and removal of mucus of fish.

xi. Shortnose sturgeon must be allowed to recover before released to ensure full recovery; and if possible, each fish should be treated with an electrolyte prior to release to help reduce stress and restore slime coat.

xii. Holding tanks must be flushed and cleaned between sampling periods; if bleach is used, extra care must be used ensuring holding tanks are sufficiently rinsed.

c. *Tissue Sampling*:

i. Care must be used when collecting genetic tissue samples (soft fin tissues) and fin ray sections. Instruments should be changed or disinfected and gloves changed between each fish sampled to avoid possible disease transmission or cross contamination of genetic material.

ii. Submission and archival of genetic tissue samples must be coordinated with Julie Carter (or the current designated RP on Permit No. 13599) at the NOAA-NOS tissue archive in Charleston, SC (843) 762-8547. Samples must be submitted to the archive at least six to 12 months after collection, or periodically when solicited by the Permits Division.

iii. The Permit Holder may receive genetic material from the NOAA-NOS archive for described research purposes by coordinating with Julie Carter (or otherwise the current designated PI Permit 13599).

iv. Light anesthesia is required for fin ray samples; no other method requiring anesthesia (i.e., , sonic tag implantation or gastric lavage), may be conducted on the same fish selected for fin-ray sectioning.

v. Careful and detailed records should be kept on the recovery and other responses from fin-ray removal on sturgeon as well the

condition and health of recaptured shortnose sturgeon. This information must be reported to NMFS in annual reports.

vi. Only designated CIs are authorized for blood sampling procedures. Blood samples, not consumed during testing, must be properly disposed of after all testing is completed.

vii. The Permit Holder may transfer biological samples to anyone listed in Section C.1 of this permit without obtaining prior written approval from NMFS. Any transfer to those not listed on the permit without first contacting the Permits Division will be subject to such conditions as NMFS deems appropriate.

viii. The terms and conditions concerning samples collected under this authorization will remain in effect as long as the sample is maintained by the Permit Holder.

d. *Tagging Conditions*:

i. PIT tags and Floy tags must be used to individually externally identify all captured fish not previously tagged. Prior to placement of PIT tags, the entire dorsal surface of each fish must be scanned with a waterproof PIT tag reader and visually inspected to ensure detection of fish tagged in other studies. Previously PIT-tagged fish must not be retagged.

ii. Researchers must not insert PIT or Floy tags, nor perform other surgical procedures on juvenile shortnose sturgeon less than 300 mm in total length.

iii. PIT tags should be injected into the left, dorsal musculature just anterior to the dorsal fin with the copper antenna oriented up for maximum signal strength, and then scanned after implantation to ensure proper tag function.

iv. Numbered Floy tags should be anchored in the dorsal fin base by inserting forward and slightly downward from the left side to the right and anchored through the dorsal pterygiophores.

v. The rate of PIT tag and Floy tag retention and the condition of recaptured sturgeon at the site of tag injection should be documented during the study with results reported to NMFS in annual and final reports.

vi. Surgical implantation of internal acoustic tags must only be attempted in water temperatures between 7°C and 27°C, when fish are in excellent condition, and never in fish on the spawning grounds.

vii. Between tagging, fin clipping or other surgical procedures, instruments should be changed or disinfected and gloves changed between each fish sampled to avoid possible disease transmission or cross contamination.

viii. To ensure proper closure of surgical incisions, a single, uninterrupted suturing technique should be applied.

ix. The total weight of all tags used to mark fish must not exceed 2% of the sturgeon's total body weight unless otherwise authorized by the Permits Division.

e. *Anesthetization*:

i. Researchers performing anesthesia on shortnose sturgeon must first have received supervised training on shortnose sturgeon or another surrogate species before doing so. Unless otherwise reported, the Permit Holder must report this training to the Permits Division prior to the activity.

ii. When preparing fresh solutions of MS-222 to anesthetize shortnose sturgeon, researchers must saturate the solution with dissolved oxygen and also buffer it to neutral pH using sodium bicarbonate.

iii. Researchers may use MS-222 at concentrations up to 150 mg/L when anesthetizing shortnose sturgeon for implanting acoustic transmitters.

iv. Only non-stressed animals in excellent health should be anesthetized.

v. When anesthetizing sturgeon in bath treatments, researchers must use restraint (e.g., netting) to prevent animals from jumping or falling out of the container.

vi. When inducing anesthesia on shortnose sturgeon, researchers must observe fish closely to establish the proper level of narcosis.

ix. Researchers must observe shortnose sturgeon closely during anesthetic recovery; and sturgeon must be fully recovered prior to release.

x. All researchers are required to wear protective clothing, gloves, and goggles when handling MS-222 powder.

xi. Unused MS-222 solutions must be disposed of safely using state adopted procedures.

f. *Gastric Lavage*

i Before initially performing gastric lavage on shortnose sturgeon, researchers must first receive supervised training on shortnose sturgeon or other surrogate sturgeon species.

ii. To avoid injury to shortnose sturgeon during gastric lavage, researchers must take precaution passing lavage tubes into position through the alimentary canal and into the fish's stomach.

iii. Prior to gastric lavage, researchers must anesthetize sturgeon with MS-222 to relax the alimentary canal and provide ease of penetration by the tubing to the proper position in the gut.

g. *Interaction with Sea Turtles*: (The following conditions were suggested by NMFS sea turtle specialists as a precautionary measure addressing how researchers handle/resuscitate incidentally captured sea turtles.)

i. Interactions with sea turtles should be documented with any pertinent detail (species, type of interaction, location, date, size, water & air temp, any obvious patterns and photos if possible (See Appendix 6).

ii. If a sea turtle is incidentally captured during netting, Researchers must use care when handling a live turtle to minimize any possible injury; and appropriate resuscitation techniques must be used on any comatose turtle prior to returning it to the water. All turtles must be handled according to procedures specified in 50 CFR 223.206(d)(1)(i). Additionally, the researcher should immediately contact the NOAA Northeast Region Marine Mammal and Sea Turtle Stranding and Entanglement Hotline at 978-281-9351 and also the New York Stranding Hotline at 631-369-9829.

h. *Atlantic Sturgeon Interaction*:

i. If an Atlantic sturgeon is incidentally captured, NMFS requests it be handled as recommended by NOAA sturgeon research protocols (Kahn and Mohead 2010) and minimally be PIT tagged, Floy tagged, genetically sampled, and released. Interactions should be reported as specified in this permit's Appendix.

C. Reports

1. The Permit Holder must submit annual, final, and incident reports, and any papers or publications resulting from the research authorized to the Permits Division.

a. Reports may be submitted by one of the following:

- through the online system at https://apps.nmfs.noaa.gov
- by email attachment to the permit analyst for this permit
- by hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Suite 13705, Silver Spring, MD 20910; phone (301) 713-2289; fax (301) 713-0376.

b. You must contact your permit analyst for a reporting form if you do not submit reports through the online system.

2. Incident reports: must be submitted within two weeks of serious injury and mortality events or exceeding authorized takes, as specified in Conditions A.2 and B.1.

a. The incident report must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional serious injury and research-related mortality or exceedence of authorized take.

b. In addition to the written incident report, the Permit Holder must contact the Permits Division by phone (301-713-2289) as soon as possible, but no later than within two business days of the incident.

c. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.

3. An annual report must be submitted to the Chief, Permits Division for each year the permit is valid. The annual report describing activities conducted during the previous permit year must follow the format in Appendix 2 including a tabular accounting of takes and a narrative description of activities and effects. .

4. A final report must be submitted, or, if the research concludes prior to permit expiration, within 180 days of completion of the research.

a. The final report summarizing activities over the life of the permit must follow the format specified by the Permits Division.

5. Research results must be published or otherwise made available to the scientific community in a reasonable period of time. Copies of technical reports, conference abstracts, papers, or publications resulting from permitted research must be submitted the Permits Division.

6. A *Biological Sample Certification, Identification and Chain of Custody Form* (Appendix 3a) must accompany shipments of genetic tissue samples shipped to the NOAA-NOS archive in Charleston, South Carolina. Samples must be submitted to the archive between six and twelve months after collection.

7. A *Field Collection Report* appearing in Appendix 3b should also accompany multiple genetic tissue samples (hard copy or spreadsheet) when shipping to the archive.

8. Note: Prior to shipping tissue samples preserved with 95% ETOH, the shipper must demonstrate knowledge of DOT safety guidelines regulating the shipment of ETOH in excepted amounts. Shipments must include a copy of your permit, including a signed copy of Appendix 3c (*Guidelines for the Shipment of Excepted Quantities of Ethanol Solutions by Air*).

9. Environmental sampling data (e.g., dissolved oxygen, temperature, net set duration, and other data associated with capture) must be recorded (Appendix 4) and be made available to NMFS in annual reports or when requested periodically.

10. Specimens or body parts of dead shortnose sturgeon should be individually preserved — preferably on ice or refrigeration — until sampling and disposal procedures are discussed with NMFS. The take should be documented by completing the sturgeon salvage form (Appendix 5).

11. NMFS also requests all Atlantic sturgeon interactions are reported to Lynn Lankshear, (Lynn.Lankshear@noaa.gov or 978-282-8473). If dead specimens are collected, this report should be documented by completing the sturgeon salvage form (Appendix 5). Specimens or body parts of dead Atlantic sturgeon should be preserved — preferably on ice or refrigeration — until sampling and disposal procedures are discussed with NMFS.

12. Interactions with Marine Mammals should be reported.

D. Notification and Coordination

1. The Permit Holder must provide written notification of planned field work at least two weeks prior to initiation of each field trip/season. If there will be multiple field trips/seasons in a permit year, a single summary notification may be submitted per year.

   a. Notification must include the
      - locations of the intended field study and/or survey routes
      - estimated dates of activities
      - number and roles of participants (for example: PI, CI, veterinarian, boat driver, safety diver, animal restrainer, Research Assistant "in training")

   b. Notification must be sent to the following Assistant Regional Administrator for Protected Resources:

      Northeast Region, Email: NER.permit.notification@noaa.gov;

NMFS, 55 Great Republic Drive, Gloucester, MA 01930; phone (978)281-9328; fax (978)281-9394.

2. To the maximum extent practical, the Permit Holder must coordinate permitted activities with activities of other Permit Holders conducting the same or similar activities on the same species, in the same locations, or at the same times of year to avoid unnecessary disturbance of animals. The appropriate Regional Office(s) listed in F.1.b may contacted be for information about coordinating with other Permit Holders.

3. In addition to the terms and conditions of this permit, Researchers must comply with protocols provided by the Regional Administrators related to coordination of research, including additional mitigation and monitoring protocols deemed necessary to minimize unnecessary duplication, harassment, or other adverse impacts from multiple permit holders.

APPROACH TO THE ASSESSMENT

NOAA Fisheries Service approaches its section 7 analyses of research permits through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species or on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The results of this step define the action area for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our exposure analyses). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our response analyses).

The final steps of our analyses – establishing the risks those responses pose to listed resources – are different for listed species and designated critical habitat (these represent our risk analyses). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of species depends on the fate of the populations that comprise them, the continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species, the populations that comprise that species, and the individuals that comprise those populations. Our risk analyses begin by

identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individuals' "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness.

When individual, listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (*see* Stearns 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a necessary condition for reductions in a population's viability, which is itself a necessary condition for reductions in a species' viability. As a result, when listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (*e.g.*, Anderson 2000, Mills and Beatty 1979, Brandon 1978, Stearns 1992). As a result, if we conclude that listed plants or animals are not likely to experience reductions in their fitness, we would conclude our assessment.

Although reductions in fitness of individuals are a necessary condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always sufficient to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and Status of Listed Resources sections of this Opinion) as our point of reference. If we conclude that reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent, we would conclude our assessment.

Reducing the viability of a population is not always sufficient to reduce the viability of the species those populations comprise. Therefore, in the final step of our analyses, we determine if reductions in a population's viability are likely to reduce the viability of the species those populations comprise using changes in a species' reproduction, numbers, distribution, estimates of extinction risk, or probability of being conserved. In this step of our analyses, we use the species' status (established in the Status of the Species section of this Opinion) as our point of reference. Our final determinations are based on whether threatened or endangered species are likely to experience reductions in their viability and whether such reductions are likely to be appreciable.

To conduct these analyses, we rely on all of the evidence available to us. This evidence might consist of monitoring reports submitted by past and present permit holders; reports from NMFS Science Centers; reports prepared by natural resource agencies in States, and other countries; reports from foreign and domestic non-governmental organizations involved in marine conservation issues; the information provided by PR1 when it initiates formal consultation; information from commercial interests; and the general scientific literature.

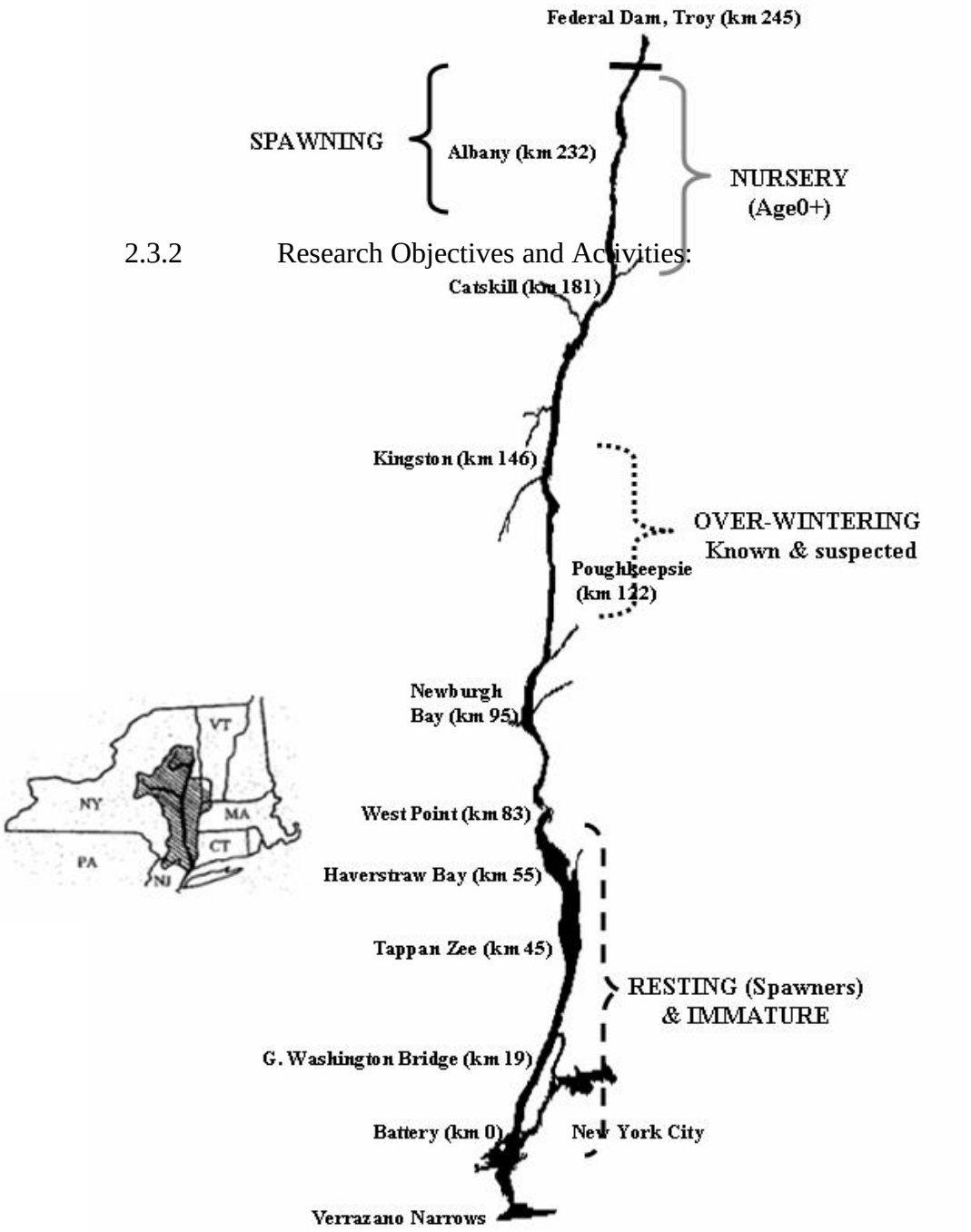
During each consultation, we conduct electronic searches of the general scientific literature using search engines such as Zoorecord, Biosis, ArticleFirst, FirstSearch, Google Scholar, JSTOR, Science Direct, and SpringerLink. We supplement these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically try to identify data or other information that supports a particular conclusion (for example, a study that suggests shortnose sturgeon will exhibit a particular response to dissolved oxygen concentrations) as well as contradicting data. When data are equivocal, or in the face of substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action would not have an adverse effect on listed species when, in fact, such adverse effects are likely.

We rank the results of these searches based on the quality of their study design, sample sizes, level of scrutiny prior to and during publication, and study results. Carefully-designed field experiments (for example, experiments that control potentially confounding variables) are rated higher than field experiments that are not designed to control those variables. Carefully-designed field experiments are generally ranked higher than computer simulations. Studies that produce large sample sizes with small variances are generally ranked higher than studies with small sample sizes or large variances.

DESCRIPTION OF THE ACTION AREA

The action area is defined in 50 CFR §402.2 as "all areas to be affected directly or indirectly by the Federal Action and not merely the immediate area involved in the action." The proposed action area consists of the portion of the Hudson River from New York Harbor to the Federal Dam at Troy, NY (Figure 1). The upper two-thirds of the river is freshwater with saltwater intrusion in the lower third occurring 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.

Figure 1. Map of Action Area - Hudson River



2.3.2 Research Objectives and Activities:

STATUS OF THE SPECIES/CRITICAL HABITAT

NMFS has determined that the action being considered in this Opinion may affect the following species that are protected under the ESA:

Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Green sea turtle	*Chelonia mydas*	Endangered

Listed Resources Not Considered Further in this Opinion

Kemp's ridley (*Lepidochelys kempii*), loggerhead (*Caretta caretta*), and green (*Chelonia mydas*) sea turtles have been observed in Long Island Sound located to the north of the Hudson River mouth. All five species of ocean-going turtles may be found outside of the river in New York coastal waters (outside of the action area) from time to time (Morreale *et al.* 1992).

In 2010, the Riverhead Foundation, the marine mammal and turtle stranding network for the lower Hudson, received a report of a dead Kemp's ridley sea turtle on the beach at Verplanck (Hudson River Mile 45). The carapace was marked by the strike of a propeller that went through the full thickness of the carapace and was most likely the cause of death. However, this is the only the second reported sea turtle recovered in the lower Hudson where limited dispersed sampling for shortnose sturgeon and boating activity would take place in the proposed study. According to the applicant, while sampling shortnose and Atlantic sturgeon in the action area of Hudson River during the last thirty years, no sea turtles have been observed or captured (K. Hattala, NYSDEC, pers. comm. to Malcolm Mohead, NMFS, 2011).

Because of the very limited upriver sightings of listed sea turtles, we do not believe that this action will affect Kemp's ridley, loggerhead, or green sea turtles, therefore they will not be discussed further in this Opinion. Netting precautions to avoid turtles have been written into the permit as an added precaution. Shortnose sturgeon will be the focus of this opinion.

No critical habitat has been designated for shortnose sturgeon; therefore, none will be affected by the proposed action. Critical habitat has not been designated for Kemp's ridley or loggerhead sea turtles; therefore, not will be affected by the proposed action. Critical habitat that has been designated for green sea turtles is not within the action area and therefore will not be affected by the proposed action.

SHORTNOSE STURGEON

Species' Description, Distribution, and Population Structure

Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada to the St. Johns River in Florida. The Shortnose sturgeon recovery plan (NMFS 1998) describes 19 shortnose sturgeon population segments that exist in the wild. Two additional, geographically distinct populations occur behind dams in the Connecticut River (above the

Holyoke Dam) and in Lake Marion on the Santee-Cooper River system in South Carolina (above the Wilson and Pinopolis Dams). Although these populations are geographically isolated, genetic analyses suggest that the shortnose sturgeon living downstream of the dams are not significantly different than those living upstream (Quattro *et al.* 2002, Wirgin *et al.* 2005).

At the northern end of the species' distribution, the highest rate of gene flow (which suggests migration) occurs between the Kennebec, Penobscot, and Androscoggin Rivers (Wirgin *et al.* in press). At the southern end of the species' distribution, populations south of the Pee Dee River appear to exchange between 1 and 10 individuals per generation, with the highest rates of exchange between the Ogeechee and Altamaha Rivers (Wirgin *et al.* 2005). Wirgin *et al.* (2005) concluded that rivers separated by more than 400 kilometers were connected by very little migration while rivers separated by no more than 20 kilometers (such as the rivers flowing into coastal South Carolina) would experience high migration rates. Coincidentally, at the geographic center of the shortnose sturgeon range, there is a 400 kilometer stretch of coast with no known populations occurring from the Delaware River, New Jersey to Cape Fear River, North Carolina (Kynard 1997). However, shortnose sturgeon are known to occur in the Chesapeake Bay, but they may be transients from the Delaware River via the Chesapeake and Delaware Canal (Skjeveland *et al.* 2000, Welsh *et al.* 2002, Wirgin *et al.* in press) or remnants of a population in the Potomac River.

Rogers and Weber (1995), Kahnle *et al.* (1998), and Collins *et al.* (2000) concluded that shortnose sturgeon are extinct from the St. Johns River in Florida and the St. Marys River along the Florida and Georgia border. In 2002, a shortnose sturgeon was captured in the St. Johns River, FL (FFWCC 2007), suggesting either immigration or a small remnant population. Rogers and Weber (1995) also concluded that shortnose sturgeon have become extinct in Georgia's Satilla River.

Table 5. Known shortnose sturgeon population densities

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Source
Saint John River	New Brunswick, Canada	1973/1977	18,000	30%	Dadswell 1979
Kennebecasis River	Canada	1998 – 2005	2,068	801 - 11,277	COSEWIC 2005
Penobscot River	ME	no data	-	-	
Kennbec River	ME	1977/1981	7,200	5,046 - 10,765	Squiers *et al.* 1982
		2003	9,500	6,942 - 13,358	Squiers 2003
Androscoggin River	ME		3,000		Squiers *et al.* 1993
Merrimack River	MA	1989 – 1990	33	18 - 89	NMFS 1998

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Source
Connecticut River	MA, CT	2003	-	1,500 - 1,800	Connecticut DEP 2003
		1998-2002	-	1,042 - 1,580	Savoy 2004
Above Holyoke Dam		1976 – 1977	515	317 - 898	Taubert 1980, NMFS 1998
		1977 – 1978	370	235 - 623	Taubert 1980, NMFS 1998
		1976 – 1978	714	280 - 2,856	Taubert 1980, NMFS 1998
		1976 – 1978	297	267 - 618	Taubert 1980, NMFS 1998
Below Holyoke Dam		1988 – 1993	895	799 - 1,018	Savoy and Shake 1992, NMFS 1998
Hudson River	NY	1980	30,311		Dovel 1979, NMFS 1998
		1995	38,000	26,427 - 55,072	Bain *et al.* 1995, NMFS 1998
		1997	61,000	52,898 - 72,191	Bain *et al.* 2000
Delaware River	NJ, DE, PA	1981/1984	12,796	10,288 - 16,367	Hastings *et al.* 1987
		1999/2003	12,047	10,757 - 13,589	Brundage and O'Herron 2003
Chesapeake Bay	MD, VA	no data	-	-	
Potomac River	MD, VA	no data	-	-	

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Source
Neuse River	NC	2001-2002	extirpated		Oakley 2003
Cape Fear River	NC	1997	>100		Kynard 1997, NMFS 1998
Winyah Bay	NC, SC	no data	-	-	
Waccamaw - Pee Dee River	SC	no data	-	-	
Santee River	SC	no data	-	-	
Lake Marion (dam-locked)	SC	no data	-	-	
Cooper River	SC	1996-1998	200	87-301	Cooke *et al.* 2005
ACE Basin	SC	no data	-	-	
Savannah River	SC, GA	1984-1992	1,676		Smith *et al.* 1995, NMFS 1998
		1984-1992		96-1075	NMFS 1998
Ogeechee River	GA	1990s	266		Bryce *et al.* 2002
		1993	266	236 - 300	Kirk *et al.* 2005
		1993	361	326 - 400	Rogers and Weber 1994
		1999/2000	195	-	Bryce *et al.* 2002
		2000	147	105 - 249	Kirk *et al.* 2005
		2004	174	97 - 874	Kirk *et al.* 2005
		2007	368	244-745	Peterson 2007 annual report
Altamaha River	GA	1988	2,862	1,069 - 4,226	NMFS 1998
		1990	798	645 - 1,045	NMFS 1998
		1993	468	315 - 903	NMFS 1998

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Source
Altamaha (continued)		2003-2005	6,320	4,387-9,249	DeVries 2006
Satilla River	GA		?	-	Kahnle *et al.* 1998
Saint Mary's River	FL		?	-	Kahnle *et al.* 1998, Rogers and Weber 1994
Saint Johns River	FL	2002	1	-	FFWCC 2007

In addition to these wild populations there are several captive populations of shortnose sturgeon (Table 6). One captive population of shortnose sturgeon is maintained at the Conte Anadromous Fish Research Center in Massachusetts, which is operated by the USFWS. These sturgeon were taken from the Connecticut River population and are currently held by Dr. Boyd Kynard under Permit No. 1239. Captive populations of shortnose sturgeon captured from the Savannah River population are housed at three USFWS hatcheries: Bear's Bluff (South Carolina), Orangeburg (South Carolina), and Warm Springs (Georgia). The USFWS provides progeny of these captive shortnose sturgeon to other facilities for research, educational purposes, and public display.

Smaller captive populations that have been developed from USFWS facilities are maintained in several facilities for educational purposes. The South Carolina Aquarium in Charleston, South Carolina, maintains a population of eight juvenile shortnose sturgeon. The Springfield Science Museum in Springfield, Massachusetts, maintains a population of five juvenile shortnose sturgeon. Captive populations are also held in the North Carolina Zoo in Asheboro, North Carolina; National Aquarium in Baltimore, Maryland; and the Riverbanks Zoological Park in Columbia, South Carolina.

Table 6. Populations reared in captivity	
Conte Fish Research Center	MA
Bear's Bluff hatchery	SC
Orangeburg hatchery	SC
Warm Springs hatchery	GA

Life History Information

Shortnose sturgeon are anadromous fish that live primarily in slower moving rivers or nearshore estuaries near large river systems. They are benthic omnivores that feed on crustaceans, insect larvae, worms and mollusks (Moser and Ross 1995, NMFS 1998, Collins *et al.* 2008) but they have also been observed feeding off plant surfaces and on fish bait (Dadswell *et al.* 1984).

During the summer and winter, adult shortnose sturgeon occur in freshwater reaches of rivers or river reaches that are influenced by tides; as a result, they often occupy only a few short reaches of a river's entire length (Buckley and Kynard 1985). During the summer, at the southern end of their range, shortnose sturgeon congregate in cool, deep, areas of rivers where adult and juvenile sturgeon can take refuge from high temperatures (Flournoy *et al.* 1992, Rogers and Weber 1994, Rogers and Weber 1995, Weber 1996). Juvenile shortnose sturgeon generally move upstream for the spring and summer seasons and downstream for fall and winter; however, these movements usually occur above the salt- and freshwater interface of the rivers they inhabit (Dadswell *et al.* 1984, Hall *et al.* 1991). Because they rarely leave their natal rivers, Kieffer and Kynard (1993) considered shortnose sturgeon to be freshwater amphidromous (*i.e.* adults spawn in freshwater but regularly enter saltwater habitats during their life). Adult shortnose sturgeon prefer deep downstream areas with soft substrate and vegetated bottoms, if present.

Shortnose sturgeon in the northern portion of the species' range live longer than individuals in the southern portion of the species' range (Gilbert 1989). The maximum age reported for female shortnose sturgeon are: 67 years in the St. John River (New Brunswick), 40 years for the Kennebec River, 37 years for the Hudson River, 34 years in the Connecticut River, 20 years in the Pee Dee River, and 10 years in the Altamaha River (Gilbert 1989 using data presented in Dadswell *et al.* 1984). Male shortnose sturgeon appear to have shorter life spans than females (Gilbert 1989).

Listing Status

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001) pursuant to the Endangered Species Preservation Act of 1966. Shortnose sturgeon remained on the list as endangered with enactment of the ESA in 1973. Shortnose sturgeon were first listed on the International Union for Conservation of Nature and Natural Resources Red List in 1986 where they are still listed as Vulnerable and facing a high risk of extinction.

Status and Trends of Shortnose Sturgeon Populations

Despite the longevity of sturgeon, the viability of sturgeon populations are highly sensitive to increases in juvenile mortality that result in chronic reductions in the number of sub-adults that recruit into the adult breeding population (Anders *et al.* 2002, Gross *et al.* 2002, Secor *et al.* 2002). This relationship caused Secor *et al.* (2002) to conclude that sturgeon populations can be grouped into two demographic categories: populations that have reliable (albeit periodic) natural recruitment and those that do not. The shortnose sturgeon populations without reliable natural recruitment are at risk of becoming critically endangered, extinct in the wild, or extinct over portions or the entirety of their range.

Several authors have also demonstrated that sturgeon populations generally, and shortnose sturgeon populations in particular, are much more sensitive to adult mortality than other species of fish (Boreman 1997, Gross *et al.* 2002, Secor *et al.* 2002). These authors concluded that sturgeon populations cannot survive fishing related mortalities that exceed five percent of an adult spawning run and they are vulnerable to declines and local extinction if juveniles die from fishing related mortalities.

Based on the information available, most shortnose sturgeon populations in the northern portion of the species range, from the Delaware River north to the St. John River in Canada, appear to have sufficient juvenile survival to provide at least periodic recruitment into the adult age classes combined with relatively low adult mortality rates sufficient to maintain the viability of most of these populations. As a result, most of these populations appear to be relatively large and stable (Table 5).

The Hudson River Population

The Hudson River currently sustains the largest and most stable of the remaining populations. Dovel (1979 Cited In: NMFS 1998) estimated the adult shortnose sturgeon population at 13,000 animals in 1979-80. Bain *et al.* (1995 Cited In: NMFS 1998) estimated the adult shortnose sturgeon population in the Hudson River at 38,000 animals in 1995 and more recently the adult population was estimated at 61,000 in 1997 (Bain *et al.* 2000) indicating that the adult segment of the population has increased several fold in less than 20 years. A recent study of shortnose sturgeon in the Hudson River (Woodland 2005) reviewed possible factors for the increase in abundance from 1979/80 to 1997. Results indicated that the increase in abundance was due to the production of several strong year classes from 1988-1991 following about five years of improved water quality (increased summertime DO concentrations and reduced contaminant concentrations) in the nursery and forage habitats in the Hudson River estuary (Woodland 2005). Recruitment levels from 1979-1987 averaged 15,361 yearlings, from 1988-1991 averaged 36,331 yearlings, and from 1992-1999 averaged 9,753 yearlings based on hindcast predictions of year class strength and supported by juvenile surveys. Woodland (2005) suggests that the variable year-class abundance is reflective of the episodic recruitment success indicative of shortnose sturgeon experiencing periodic environmental conditions favorable to the growth and survival of the early life stages.

However, the future viability of the Hudson River population remains uncertain because it may be entering a period of low juvenile survival that is one of several factors that places other shortnose sturgeon populations at a high risk of extinction (9,753 yearlings average from 1992-1999). Peterson *et al.* (2000) presented evidence to support their assertion that recruitment of Atlantic sturgeon in the Hudson River had declined by as much as 80 percent between the late 1970s and the mid-1990s due to major decline in recruitment levels. They concluded that recruitment rates could not sustain the Atlantic sturgeon population in the Hudson River and the population faced a high risk of extinction as a result. There is considerable overlap of habitat and critical life stages of both Atlantic and shortnose sturgeons. Juveniles of both species occupy identical habitat during the summer and winter, adult shortnose and juvenile Atlantic sturgeon occupy the same habitat in the summer, and eggs and larvae of both species occupy the same habitat during the spring (Bain 1997). While the increase in recruitment rates for shortnose sturgeon coincided with decreases in Atlantic sturgeon recruitment rates both species exhibited reduced recruitment rates by the mid-1990s. Because of similarities in their response to physical and chemical variables in their environment (Dwyer *et al.* 2000, Jarvis *et al.* 2001, Kieffer *et al.* 2001, Secor and Niklitschek 2001, Campbell and Goodman 2004) and their ecology and distribution in the Hudson River (Bain 1997), the factors that are reducing the survival of juvenile Atlantic sturgeon probably affect juvenile shortnose sturgeon as well.

ENVIRONMENTAL BASELINE

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

The following information summarizes the primary human and natural phenomena in the Hudson River that are believed to affect the status and trend of endangered shortnose sturgeon and the probable responses of the sturgeon to these phenomena.

Commercial and Recreational Fishing

Directed harvest of shortnose sturgeon is prohibited by the ESA. However, shortnose sturgeon are taken incidentally in other anadromous fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979, Dovel *et al.* 1992, Collins *et al.* 1996). Commercial and recreational shad fisheries operating in the Merrimack, Connecticut, Hudson, Delaware, Cape Fear, and various rivers in South Carolina and Georgia are known to incidentally capture shortnose sturgeon. In the Saint John River estuary, shortnose sturgeon are taken incidentally in shad, salmon, striped bass, and alewife fisheries. In most cases fish are returned to the river, presumably unharmed. Moser and Ross (1993) found that captures of shortnose sturgeon in commercial shad nets disrupted spawning migrations in the Cape Fear River, and Weber (1996) reported that these incidental captures caused abandonment of spawning migrations in the Ogeechee River, Georgia. Poaching is likely another fishing threat, but its impacts to individual population segments is unknown. Poaching may be more prevalent where importations, commercial harvest, or commercial culture of sturgeon occurs.

Cooling Water Intakes and Power Plants

Power generation by 13 facilities in the Hudson River estuary cumulatively kill several billion fish annually, including shortnose sturgeon (NYSDEC 1996). In particular, shortnose sturgeon are susceptible to impingement (adult fish) or entrainment (larval fish) on cooling water intake screens (NMFS 1998). Dadswell *et al.* (1984) reported that larval and juvenile shortnose sturgeon in different Atlantic populations have been killed after being impinged on the intake screens or entrained in the intake structures of power plants on the Delaware, Hudson, Connecticut, Savannah, and Santee rivers.

Water Quality

Point source discharges and compounds associated with discharges (contaminants, including toxic metals, polychlorinated aromatic hydrocarbons, pesticides, and polychlorinated biphenyls (PCBs)) contribute to poor water quality and may also impact the health of sturgeon populations.

Poor water quality can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989, Sindermann 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Available data suggest that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Several characteristics of shortnose sturgeon (i.e., long lifespan, extended residence in estuarine habitats, benthic predator) predispose the species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979). Chemicals and metals such as chlordane, DDE, DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later consumed by benthic feeders, such as sturgeon or macroinvertebrates, and then work their way into the food web. Some of these compounds may affect physiological processes and impede a fish's ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing dissolved oxygen (DO), altering pH, and altering other physical properties of the river. Exposure to sufficient concentrations of these chemicals can cause lethal and sub-lethal effects such as: behavioral alterations, deformities, reduced growth, reduced fecundity, and reduced egg viability (USFWS 1993, Ruelle and Keenlyne 1993).

Elevated levels of environmental contaminants, including chlorinated hydrocarbons, in several fish species are associated with reproductive impairment (Cameron *et al.* 1992, Longwell *et al.* 1992), reduced egg viability (von Westernhagen *et al.* 1981, Hansen 1985, Mac and Edsall 1991), and reduced survival of larval fish (Berlin *et al.* 1981, Giesy *et al.* 1986). Contaminant analysis of tissue from a shortnose sturgeon in the Kennebec River revealed the presence of 14 metals, one semivolatile compound, one PCB Aroclor, and dioxins. Of these chemicals, cadmium and zinc were reported in quantities above the levels of adverse effects reported in the literature.

Dams

Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration, and causing mortalities to fish that become impinged or entrained in turbines. In all but one of the northeast rivers supporting sturgeon populations (Connecticut River), the first dam on the river marks the upstream limit of the shortnose sturgeon's population range (Kynard 1997). In all of these rivers, shortnose sturgeon spawning sites occur just below the dams, leaving all life stages vulnerable to perturbations of natural river conditions caused by the dam's operation. The most significant dam within the action area of this proposed permit amendment is the Federal Dam in Troy, NY, which separates the Upper and Lower Hudson River.

Sturgeon appear unable to use some fishways (e.g., ladders) but have been transported in fish lifts (Kynard 1998). Because sturgeon require adequate river flows and water temperatures for spawning, any alterations that dam operations pose on a river's natural flow pattern, including increased or reduced discharges, can be detrimental to sturgeon reproductive success. Additionally, dam maintenance activities, such as minor excavations along the shore, release silt

and other fine river sediments that could be deposited in nearby spawning sites and degrade critical spawning habitat.

Dredging

Maintenance dredging of Federal navigation channels can adversely affect or jeopardize shortnose sturgeon populations due to their benthic nature. Hydraulic dredges (e.g., hopper) can lethally harm sturgeon by impinging or entraining sturgeon in dredge dragarms and impeller pumps. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Potential impacts from hydraulic dredge operations may be avoided by imposing work restrictions during sensitive time periods (i.e., spawning, migration, feeding) when sturgeon are most vulnerable to mortalities from dredging activity.

Land Use Practices

Although most of the Hudson River's upper basin is forested, the majority of the landscape within 5 kilometers of the Hudson River has been converted to human uses. The basin as a whole is 62% forested, while 25% of the basin is used for agriculture, 8% is urban and 5% experiences other land uses (Jackson *et al.* 2005). These land uses include industrial, commercial, residential, and recreational developments (NYSDCR 2004b). Increased human development tends to increase runoff from agricultural, industrial, and urban land activities. In addition, deforestation and clearing of land and vegetation may cause silt, sand, and mud runoff. From north to south, the major urban centers below the Troy dam include the cities of Albany (population ~94,172), Kingston (~22,620), Poughkeepsie (~29,633), Newburgh (~28,201), and metropolitan New York City (~8,274,527) (United States Census Bureau 2007).

Shipping

The Hudson River is a major transportation and freight corridor for much of the northeastern United States (Everly and Boreman 1999). A dredged shipping channel maintains an open corridor for large commercial vessels to reach the Port of Albany (at RM 144). Along the lower Hudson River (New York City to Troy), the shipping channel maintains a depth of approximately 35 feet. However, in other parts of the river the channel depth is as great as 60 feet (Barnthouse *et al.* 1977, Levinton and Waldman 2006). This thriving shipping area poses deleterious effects to shortnose sturgeon populations due to disruption of benthos and habitat, ship strikes, and introduction of contaminants into Hudson River waters.

Research

Excluding the proposed permit detailed in this Opinion, there are 17 permits (Table 7) authorizing take of shortnose sturgeon on the East coast of the United States. Shortnose sturgeon research has been authorized in New York State waters by three permits: Nos. 1575, 1580, and the applicant's current Permit No. 1547-02. Permit No. 1575 is authorized to sample 250 adult/juvenile shortnose sturgeon at six stations under and along the Tappan Zee bridge and at three locations within 700 feet north of the bridge all between river miles 26 and 29 of the

Hudson River. Permit No. 1580 is authorized to sample 82 adult/juvenile shortnose sturgeon between the Troy Dam and the Atlantic Ocean, in the lower 152 miles of the Hudson River estuary. In addition, Permit No. 1580 is authorized to lethally take 40 shortnose sturgeon larvae, or early life stages (ELS), on the Hudson River.

Table 7. Existing shortnose sturgeon research permits similar to the proposed action.

Permit No.	***Location***	***Authorized Take***	***Research Activity***
10115 Expires: 8/3/2013	Saltilla & Saint Marys Rivers, GA & FL	85 adult/juv 20 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, collect ELS
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
10037 Expires: 4/30/2013	Ogeechee River and Estuary, GA	150 adult/juv. (2 lethal), 40 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, fin-ray section, anesthetize, laparoscopy, blood collection, radio tag, collect ELS
1447 Expires: 2/28/2012	S. Carolina Rivers and Estuaries	100 adult/juv. (2 lethal), 100 ELS	Capture, handle, measure, weigh, PIT and FLOY tag, transmitter tag, anesthetize, tissue sample, gastric lavage, collect ELS
1505 Expires: 5/31/2011	S. Carolina Rivers and Estuaries	98 adult/juv. (2 lethal), 200 ELS	Capture, handle, measure, weigh, PIT and FLOY tag, transmitter tag, anesthetize, laparoscopy, blood collection, tissue sample, gastric lavage, collect ELS
1542 Expires: 7/31/2011	Upper Santee River Basin, SC	5 adult/juv.; 100 ELS	Capture, handle, weigh, measure, PIT and Floy tag, tissue sample, ELS collection
1543 Expires:11/30/2011	Upper Santee River Basin, SC	3 adult/juv.	Capture, handle, weigh, measure, tissue sample
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

Permit No.	*Location*	*Authorized Take*	*Research Activity*
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
1547-02***** Expires:10/31/2011	Hudson River, (Haverstraw & Newburgh), NY	500 adults/juv.	Capture, handle, weigh, measure, PIT & Carlin tag, genetic tissue sample, and gastric lavage
1575 Expires11/30/2011	Hudson River (Tappan-Zee), NY	250 adult/juv.	Capture, handle, measure
1580 Expires: 3/31/2012	Hudson River and Estuary, NY	82 adult/juv.; 40 ELS	Capture, handle, measure, weigh, PIT tag, Carlin tag, photograph, tissue sample, collect ELS
1549-02 Expires: 1/31/2012	Upper Conn. River, Merrimack River, MA	673 adult/juv. (5 lethal), 1,430 ELS from East Coast rivers	Capture, handle, measure, weigh, anesthetize, PIT tag, TIRIS tag, radio tag, temperature/depth tag, tissue sample, borescope, laboratory tests, photographs, collect ELS
15614 Expires: 5/23/2016	Lower Conn. River & Estuary., CT	500 adult/juv (2 lethal); 300 ELS	Capture, handle, measure, weigh, PIT & Floy tag acoustic tag, gastric lavage, fin ray section, collect ELS
1578-01 Expires: 11/30/2011	Kennebec Complex and Estuary, ME	500 adult/juv.; 30 ELS	Capture, handle, measure, weigh, tissue sample, PIT tag, acoustic tag, lavage, anesthetize, collect ELS
1595-04 Expires: 3/31/2012	Penobscot River and Estuary, ME	300 adult/juv. (2 lethal); 50 ELS	Capture, handle, measure, weigh, borescope, tissue sample, blood sample, PIT & Floy tag, anesthetize, acoustic tag, collect ELS, lavage, scute sample

Conservation Actions

The New York State Department of Environmental Conservation (NYSDEC), is responsible for implementing programs for conserving and managing the state's Forests, Open Spaces, Watersheds, Lakes & Rivers, Oceans & Estuaries, Wetlands, Groundwater, Dam Safety, Coastal & Flood Protection, Water Supply & Conservation, and Mining & Reclamation. The Hudson River Estuary Action Agenda program is one such conservation and management program with

great implications for shortnose sturgeon. The predominant actions within the plan are to ensure water quality in the Hudson River and to conserve wildlife within the Hudson River. This will be done during 2010-2014 by achieving swimmable water quality on the Hudson, upgrading water and sewer facilities for community revitalization and smart growth, protecting water quality in streams, drinking water supplies and the estuary, reducing sewer and storm water outflows, and cleaning up toxic pollution.

Other federal agencies have contributed to conservation actions benefitting shortnose sturgeon. NMFS published a recovery plan in December 1998 outlining actions that need to be taken in order to recover the species (NMFS 1998). The EPA monitors Hudson River PCB's. EPA's February 2002 Record of Decision (ROD) for the Hudson River PCBs Superfund Site addresses risks and ecological receptors associated with PCBs in the in-place sediments of the Upper Hudson River. EPA's 2002 ROD calls for removing more than 100,000 pounds of PCBs from targeted hotspots in the Upper Hudson using environmental dredging (EPA 2002). Additionally, the EPA works with New York State to monitor contaminants under the Federal Clean Water Act.

Impact of the Environmental Baseline on Shortnose Sturgeon

The above activities along the Hudson River pose threats to its shortnose sturgeon population in the following ways. Many activities cause *death* – definite removal of individual fish from the Hudson River population segment – at the adult, juvenile, and larval stages. Other activities cause *injury* to shortnose, increasing stress levels and decreasing their survival potential. Still, other activities *alter habitat*, potentially changing spawning and survival patterns of these fish.

Hudson River activities potentially causing death to individual shortnose sturgeon are bycatch in commercial and recreational fishing, cooling water intakes and power plants, dredging, and research. In Connecticut, New York, and Maine, approximately 20 sturgeon are killed annually by commercial and recreational fishing industries (NMFS 1998). Hydroelectric or nuclear power plants must use rivers or lakes as sources of running turbines or as cooling mechanisms. Adult and larval shortnose sturgeon are known to be killed or impinged on the screens that cover the cooling water intake screens (Hoff and Klauda 1979, Dadswell *et al.* 1984, NMFS 1993). Dadswell *et al.* (1984) reported that larval and juvenile shortnose sturgeon in the different populations along the Atlantic have been killed after being impinged on the intake screens or entrained in the intake structures of power plants on the Delaware, Hudson, Connecticut, Savannah and Santee rivers. Also, Hoff and Klauda (1979) showed that between 1969 and 1979, 39 shortnose sturgeon were impinged at power plants in the Hudson River and approximately 160 shortnose sturgeon were estimated to be impinged on intake screens at the Albany Steam Generating Station (Albany, NY) between October 1982 and September 1983 (E Radle, pers. comm. as cited in NMFS 1998). During dredging activities, hydraulic dredges can kill sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to kill shortnose sturgeon. Finally, research under NMFS-issued Permit No. 1580 is authorized to lethally take 40 larvae on the Hudson River.

All of the Hudson River activities in the Environmental Baseline section have the potential to injure individual shortnose sturgeon. Commercial and recreational fishing industries that catch

shortnose incidentally might return living fish to the river, presumably unharmed, however each fish might have sustained injury in the process. The operation of power plants can also have unforeseen and detrimental impacts to water quality which can injure shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low DO water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that 20 shortnose sturgeon were killed during this low DO event.

Water quality changes from dredging, shipping, land use practices, point and non-point source pollution could also injure shortnose sturgeon by way of changes in DO concentration or introduction of waterborne contaminants. DO concentrations can be affected by maintenance dredging of Federal navigation channels and other waters. Apart from entrainment, dredging can also change DO and salinity gradients in, and around, the channels (Jenkins *et al.* 1993, Campbell and Goodman 2004, Secor and Niklitschek 2001). Dredging operations may pose risks to shortnose sturgeon by destroying or adversely modifying their benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Since shortnose sturgeon are benthic omnivores, the modification of the benthos could affect the quality, quantity, and availability of sturgeon prey species.

Along with fluctuations in the DO and salinity concentrations, other waterborne contaminants may affect the aquatic environment, causing injury to shortnose sturgeon. These contaminants may come from land use practices, or point and non-point source pollution. Issues such as raised fecal coliform and estradiol concentrations affect all of the wildlife using the river as a habitat. The impact of many of these waterborne contaminants on shortnose sturgeon is unknown, but they are known to affect other species of fish in rivers and streams. These compounds may enter the aquatic environment via wastewater treatment plants, agricultural facilities, as well as runoff from farms (Folmar *et al.* 1996, Culp *et al.* 2000, Wildhaber *et al.* 2000, Wallin *et al.* 2002). For instance, estrogenic compounds are known to affect the male-female sex ratio in streams and rivers via decreased gonadal development, physical feminization, and sex reversal (Folmar *et al.* 1996). Although the effects of these contaminants are unknown in shortnose sturgeon, Omoto *et al.* (2002) found that by varying the oral doses of estradiol-17β or 17α-methyltestosterone given to captive hybrid (*Huso huso* female × *Acipenser ruthenus* male) "bester" sturgeon they could induce abnormal ovarian development or a lack of masculinization. These compounds, along with high or low DO concentrations, can result in sublethal effects that may have long-term consequences for small populations.

Other NMFS-permitted research activities could also injure shortnose sturgeon in the Hudson River. The applicant has an existing permit, No. 1547-01, in which they are authorized to capture a maximum of 500 adult and juvenile shortnose sturgeon with gill nets, measure, weigh, genetic tissue sample, scan for tags, PIT and Carlin tag (if untagged), and release. Since 2003, the applicant has captured 384 shortnose sturgeon without the occurrence of mortality (NYSDEC 2009). However, fish captured may have been injured in a way that was not quantified by the researchers. Similarly, Hudson River Permit Nos. 1575 and 1580, are authorized to sample 330

adult/juvenile shortnose sturgeon in combination (these studies are not performing gastric lavage). Again, fish captured may be injured in a way that is not quantified by researchers.

Hudson River activities potentially altering the habitat of shortnose sturgeon are dams, dredging, land use activities, and shipping. Hydroelectric dams may alter shortnose sturgeon habitat by varying river flows or temperatures necessary for successful spawning and/or migration. Due to their benthic nature, dredging for shipping and other activities destroys shortnose feeding areas, disrupts spawning migrations, and fills spawning habitat with resuspended fine sediments. Land use activities also have the capacity to fill spawning habitat with sediments if those activities release sand and silt into the Hudson River.

In conclusion, the Hudson River is one of the most used rivers in the United States. Subsequently the water quality in the river is poor, but has been getting better since the implementation of the Clean Water Act in 1972. Although the Hudson basin has suffered from land use practices and pollution including continued PCB contamination, the shortnose sturgeon population there is the largest of the remaining populations of this species. With studies showing population increases in the last 20 years, it appears that the shortnose sturgeon population in the Hudson River could be improving. However, due to the decline in estimated recruitment (from highs averaging 36,331 from 1988-1991 to highs averaging 9,753 from 1992-1999), the current impact of human activities and recovery of shortnose sturgeon is somewhat uncertain.

EFFECTS OF THE PROPOSED ACTION

In this section of the Opinion, we assess the probable direct and indirect effects of authorizing the proposed action on shortnose sturgeon in the action area. We also summarize the results of studies that have examined the direct and indirect effects of each sampling procedure on these fish. We rely on these summaries of the literature to determine how individual shortnose sturgeon are likely to respond upon being exposed to a particular sampling procedure. Based on this body of information, we then assess the risks the activities contained in the proposed permit pose first to particular shortnose sturgeon populations, then to the species as they are listed.

The specific stressors associated with the proposed permit (No. 16439) are capture, handling, PIT and Floy tagging, gastric lavage, blood sampling, genetic sampling, fin ray sampling, acoustic transmitter implantation, anesthetization, and incidental mortality throughout the life of the permit. The following sections provide specific details of the stressors associated with each procedure and summarize the available data on the responses of individuals that have been exposed to the procedures.

Capture

Up to a total of 240 juvenile and/or adult shortnose sturgeon per year in years 1-3 and up to 2,340 shortnose sturgeon per year in years 4-5 would be captured annually using a standardized netting protocol with anchored gillnets, drift gillnets, or trawl. Gillnet mesh size would range from 5-18 cm (2-7 inch) (stretch measure) and be 61m long by 2.4m deep. Gillnets would be set during the ice-free period of each year. In addition to gillnets, trawls would also be employed in

sampling. Trawls would be towed along the bottom at speeds between approximately 2.5-3.0 knots for 5-10 minutes, also during the ice-free period of each year.

Gillnets

Entanglement in gillnets could result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Moser and Ross 1995, Collins *et al.* 2000, Moser *et al.* 2000, Kahn and Mohead 2010). Recently, on June 3, 2010, Hal Brundage experienced one shortnose sturgeon gillnet mortality in the Delaware River (7.7 ppm D.O., 26.7C, in a 90 minute net set). The shortnose sturgeon was a post spawner and was 772 mm weighing about 2.9kg (6.5 lbs), which is a fairly small fish. It was also the fish's first time captured. However, historically, the majority of shortnose sturgeon mortality during scientific investigations has been directly related to netting mortality and as a function of numerous factors including water temperature, low D.O. concentration, soak time, mesh size, net composition, and netting experience.

Table 8: The number and percentage of shortnose sturgeon killed by gill nets associated with scientific research permits prior to 2005.

	Permit Number					
	1051	1174	1189	1226	1239	1247
Time Interval	1997, 1999 – 2004	1999–2004	1999, 2001 – 2004	2003–2004	2000 – 2004	1988 – 2004
Sturgeon captured	126	3262	113	134	1206	1068
Sturgeon mortality	1	7	0	0	5	13
Percentage	0.79	0.22	0	0	0.41	1.22

In 2005, NMFS-PR began analyzing the results of previous research and updating permit conditions to reduce the chances of stress and mortality to shortnose sturgeon during capture. Since that time, there have been two mortalities caused by capture (Table 9), each occurring in 2010.

Reviewing permits issued prior to 2005, the primary causes of mortality were associated with high temperatures, low D.O., and long net set durations. Despite more recent permit modifications reducing mortality of sturgeon in nets, there is a chance of delayed mortality occurring without being reported. There is unfortunately no way to estimate the rate of delayed mortality, but NMFS believes it would be minimal based on reports of various species of sturgeon captured and transported to rearing facilities.

Table 9. Number of shortnose sturgeon mortalities under recent scientific research permits

Permit Number	Shortnose sturgeon captured	Shortnose sturgeon mortalities
1420 (2005-2009)[1]	1472	0
1447 (2006-2010)	107	0
1444 (2005-2009)[1]	1	0
1449 (2007-2009)[1]	50	0
1486 (2006-2009)[1]	416	0
1505 (2006-2010)	279	0
1516 (2007-2010)	344	0
1547-02 (2006-2010)[2]	150	0
1549 (2006-2010)	522	0

Permit Number	Shortnose sturgeon captured	Shortnose sturgeon mortalities
1575 (2007-2010)	14	0
1580 (2007-2010)	112	0
1595 (2007-2010)	695	1
10037 (2007-2010)	235	0
10115 (2008-2010)	12	0
14394 (2010)	383	
14604 (2010)	34	1
14759 (2010)	0	0
Totals	4,826	2

1. Expired permit.
2. Permit in the Hudson River replaced by proposed File 16439.

Shortnose sturgeon mortalities shown in Table 9 were reported as being caused by atypical events, such as increased water flows from the previous day's sampling. The applicant (old Permit number 1547-02) has maintained a record of no verifiable mortalities while engaged in current authorized research on shortnose and Atlantic sturgeon within the Hudson River (same proposed action area). However, the applicant has also been working under much more conservative sampling effort since 2006 (Permits No. 1547-01, -02), taking an average of 50 shortnose sturgeon annually, and has not been performing surgical procedures other than gastric lavage under light anesthesia. Consequently, because the current application requests authorization for capturing 5,400 shortnose sturgeon over five years of increased netting activity, having potentially much larger individual catches and associated stress, NMFS would anticipate mortality and/or delayed harmful stress associated with capture and increased netting activity. This is further analyzed in the incidental mortality section below.

Trawls

Capture by trawl could result in similar effects to shortnose sturgeon as reported above. NMFS protocols (Kahn and Mohead 2010) outline recommendations for trawl capture, and researchers under the proposed permit would adhere to these protocols. A standard haul should be approximately 300 to 500 feet, lasting approximately 10 minutes, and towed at a range of three to five knots (Gutreuter *et al.* 1995). At 1-2.5 knots and 5-10 minutes, the proposed research is well within this standard haul range. This reduced speed and haul time minimizes the amount of time and severity of entanglement that occur for captured fish. Because researchers would be conducting trawls within recommended protocols, we expect a minimal risk of direct mortality.

Expected Response to Capture

As demonstrated above, there is a chance that shortnose sturgeon could die in nets, but mitigation measures included in the proposed activities should reduce the risk associated with sturgeon capture. The increased netting effort, compared to applicant's previous permit, could increase the risk of a shortnose mortality. To limit stress and mortality of sturgeon due to capture, the researchers have agreed to NMFS PR's more conservative recent set of netting conditions. Specifically, during lower water temperatures (<15°C), soak times of nets would not exceed 14 hours; at water temperatures between 15°C and 20°C, net sets would not exceed 4 hours; at water temperatures between 20°C and 25°C, net sets would not exceed two hours; and at water temperatures above 25°C, net sets would not exceed one hour and netting activities would cease at 28°C or higher. Gear would be deployed only in waters where dissolved oxygen

concentrations are at least 4.5 mg/l at the deepest depth sampled by the gear for the entire duration of deployment. Hauls are well within recommended protocols for research on sturgeon. Lastly, related to capture, while it is possible that interaction with the capture methods described above could result in fewer adults reaching spawning grounds—by externally tagging pre-spawning fish in the fall and winter— it is anticipated that spawning runs would not be interrupted due to timing and placement.

Therefore, the capture methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in the Hudson River. By extension, capture is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the netting protocols are used and closely followed. There is a risk of incidental mortality, which is analyzed further (below) in this Opinion.

Handling

Up to 5,400 shortnose sturgeon would be handled for length and weight measurements and/or the other proposed methods under this proposed research authorization. Fish would be held in a box for examination, measuring, tissue sampling, and tagging. To weigh, captured shortnose sturgeon would be placed in a capture sling and suspended from a digital scale. In normal processing of most fish (i.e., those not undergoing additional procedures such as gastric lavage, acoustic tagging, or fin ray sampling), the sling would be lowered over the side of the boat into the water, opened, and the sturgeon allowed to swim away.

Handling and restraining shortnose sturgeon may cause short term stress responses, but those responses are not likely to result in pathologies because of the short duration of handling. Handling stress can escalate if sturgeon are held for long periods after capture. Conversely, stress is reduced the sooner fish are returned to their natural environment to recover. Signs of handling stress are redness around the neck and fins and soft fleshy areas, excess mucus production on the skin, and a rapid flaring of the gills. Sturgeon are a hardy species, but these fish can be lethally stressed during handling when water temperatures are high or D.O. is low (Moser *et al.* 2000, Kahn and Mohead 2010). Sturgeon may inflate their swim bladder when held out of water (Moser *et al.* 2000, Kahn and Mohead 2010) and if they are not returned to neutral buoyancy prior to release, they will float and be susceptible to sunburn and bird attacks. In some cases, if pre-spawning adults are captured and handled, it is possible that they would interrupt or abandon their spawning migrations after being handled (Moser and Ross 1995).

Expected Response to Handling

Although sturgeon are sensitive to handling stress, the proposed methods of handling fish are consistent with the best management practices recommended by Moser *et al*. (2000) and Kahn and Mohead (2010) and endorsed by NMFS and, as such, should minimize the potential handling stress and therefore minimize indirect effects resulting from handling in the proposed research. To minimize capture and handling stress, the proposed research plans to hold shortnose sturgeon in net pens until they are processed, at which time they would be transferred to a processing station on board the research vessel. For most procedures planned, the total time required to complete routine handling and tagging would be no more than 15 minutes. Moreover, following

processing, fish would be returned to the net pen for observation to ensure full (return to equilibrium, reaction to touch stimuli, return of full movement) recovery prior to release.

Therefore, handling as proposed is not likely to reduce the viability of the shortnose sturgeon population in the Hudson River. By extension, handling is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the proposed methodology and proposed mitigation measures are closely followed.

Passive Integrated Transponder (PIT) Tags

All shortnose sturgeon captured that are previously unmarked would be marked with PIT tags. No fish would be double-tagged with PIT tags. Prior to PIT tagging, the entire dorsal surface of each fish would be scanned to detect previous PIT tags. Unmarked shortnose sturgeon would receive PIT tags by injection using 11.9 mm x 2.1 mm PIT tags and a 12 gauge needle at an angle of 60^{o} to 80^{o} in the dorsal musculature (anterior to the dorsal fin). The rate of PIT tag retention would be documented and reported to NMFS in annual reports.

PIT tags have been used with a wide variety of animal species that include fish (Clugston 1996, Skalski *et al.* 1998, Dare 2003), amphibians (Thompson 2004), reptiles (Cheatwood *et al.* 2003, Germano and Williams 2005), birds (Boisvert and Sherry 2000, Green *et al.* 2004), and mammals (Wright *et al.* 1998, Hilpert and Jones 2005). When PIT tags are inserted into animals that have large body sizes relative to the size of the tag, empirical studies have generally demonstrated that the tags have no adverse effect on the growth, survival, reproductive success, or behavior of individual animals (Brännäs *et al.* 1994, Elbin and Burger 1994, Keck 1994, Jemison *et al.* 1995, Clugston 1996, Skalski *et al.* 1998, Hockersmith *et al.* 2003). However, some fish, particularly juvenile fish, could die within 24 hours after tag insertion, others could die after several days or months, and some could have sub-lethal reactions to the tags.

If mortality of fish occurs, they often die within the first 24 hours, usually as a result of inserting the tags too deeply or from pathogen infection. About 1.3% of the yearling Chinook salmon (*Oncorhynchus tshawytscha*) and 0.3% of the yearling steelhead (*O. mykiss*) studied by Muir *et al.* (2001) died from PIT tag insertions after 24 hours. In the only study conducted on sturgeon mortality and PIT tags, Henne *et al.* (unpublished) found that 14 mm tags inserted into shortnose sturgeon under 330 mm causes 40% mortality after 48 hours, but no additional mortalities after 28 days. Henne *et al.* (unpublished) also show that there is no mortality to sturgeon under 330mm after 28 days if 11.5mm PIT tags are used. Gries and Letcher (2002) found that 0.7% of age-0 Atlantic salmon (*Salmo salar*) died within 12 hours of having PIT tags surgically implanted posterior to their pectoral fins, but nine months later, 5.7% of the 3,000 tagged fish had died. At the conclusion of a month long study by Dare (2003), 325 out of 144,450 tagged juvenile spring chinook salmon died, but only 42 died in the first 24 hours.

Studies on a variety of fish species suggest that attachment of tags, both internal and external, can result in a variety of sub-lethal effects including delayed growth and reduced swimming performance (Morgan and Roberts 1976, Isaksson and Bergman 1978, Bergman *et al.* 1992, Strand *et al.* 2002, Bégout Anras *et al.* 2003, Robertson *et al.* 2003, Sutton and Benson 2003, Brattey and Cadigan 2004, Lacroix *et al.* 2005). Larger tags and external tags have more adverse

consequences, such as impaired swimming, than smaller tags (Bégout Anras *et al.* 2003, Sutton and Benson 2003).

Expected Response to PIT Tags

PIT tags would be used for permanently marking and identifying individual fish by injecting the tags intramuscularly anterior to the dorsal fin. These biologically inert tags have been shown not to cause problems associated with some other methods of tagging fish, that is, scarring and damaging tissue or otherwise adversely affecting growth or survival (Brännäs *et al*. 1994). As such, the proposed tagging of shortnose sturgeon with PIT tags is unlikely to have significant impact on the reproduction, numbers, or distribution of shortnose sturgeon. However, there is one record of young sturgeon mortality within the first 24-48 hours of PIT tag insertion as a result of the tags being inserted too deeply. Henne *et al*. (unpublished) found 14 mm tags injected into smaller shortnose sturgeon caused mortality after 48 hours; also, he inferred from his results that either 11.5 or 14 mm PIT tags would not cause mortality in sturgeon equal to or longer than 330 mm (TL). To address this concern, the applicant would use smaller PIT tags and would not use the 14 mm tags.

Therefore, the PIT tag methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in the Hudson River. By extension, PIT tagging is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the appropriate sizes of PIT tags are used and tagging protocols are closely followed.

Floy Tags

All shortnose sturgeon captured would also be marked with Floy tags. This tagging method could help make collection of information useful for the assessment of the sturgeon population in the action area. In all captured sturgeon, Floy tags would be anchored in the dorsal fin musculature base and inserted forwardly and slightly downward from the left side to the right through dorsal pterygiophores. After removing the injecting needle, the tag would be spun between the fingers and gently tugged to be certain it is locked in place. During the study, the rate of Floy tag retention would be documented and reported in NMFS annual reports.

Smith *et al.* (1990) compared the effectiveness of dart tags with nylon T-bars, anchor tags, and Carlin tags in shortnose and Atlantic sturgeon. Carlin tags applied at the dorsal fin and anchor tags in the abdomen showed the best retention, and it was noted that anchor tags resulted in lesions and eventual breakdown of the body wall if fish entered brackish water prior to their wounds healing. However, Collins *et al.* (1994) found no significant difference in healing rates (with T-bar tags) between fish tagged in freshwater or brackish water. Clugston (1996) also looked at T-bar anchor tags placed at the base of the pectoral fins and found that beyond two years, retention rates were about 60%. Collins *et al.* (1994) compared T-bar tags inserted near the dorsal fin, T-anchor tags implanted abdominally, dart tags attached near the dorsal fin, and disk anchor tags implanted abdominally. They found that for the long-term, T-bar anchor tags were most effective (92%), but also noted that all of the insertion points healed slowly or not at all, and, in many cases, minor lesions developed.

Expected Response to Floy Tags

The use of Floy tags and PIT tags to mark shortnose sturgeon are duplicative means to identify captured fish. However, we believe that the practice is not expected to significantly impact sturgeon health. The attachment of tags may cause some discomfort and pain to shortnose sturgeon. Generally, there is little observable reaction to the injection of PIT tags. However, the injection of Floy tags may result in more noticeable reactions than the injection of PIT tags. There is also a greater potential for injury from the insertion of Floy tags than PIT tags because the tag is typically interlocked between interneural cartilage. Injury may result during attachment, although the potential for this is seriously reduced when tags are applied by experienced biologists and technicians. Mortality is unlikely for either tag type (PIT or Floy).

Injection of Floy tags into the dorsal musculature, however, may result in raw sores that may enlarge overtime with tag movement (Collins *et al.* 1994; Guy *et al.* 1996). Beyond the insertion site, it is unknown what effects the on fish the attachment of Floy tags may have. We know of no long-term studies evaluating the effect of these tags on the growth or mortality of tagged shortnose sturgeon. Anecdotal evidence recounted in NOAA's protocol (Moser *et al*. 2000) suggests that Floy tags have little impact on the fish because a number of shortnose were recovered about 10-years after tagging although no data are available to evaluate any effects on growth rate. Studies on other species suggest that the long-term effect of injecting anchor tags into the muscle may be variable. Researchers have observed reduced growth rates in lemon sharks and northern pike from tagging, whereas studies of largemouth bass did not depict changes in growth rates (Tranquilli and Childers 1982; Manire and Gruber 1991; Scheirer and Coble 1991).

To lessen known negative impacts described above using the Floy tag, sterile tagging technique would be used and methods would require to subsequently monitor dorsal fin tag sites of recaptured sturgeon for any lesions. Additionally, results of tag retention and fish health would be reported to NMFS in annual reports and as requested by NMFS. If impacts of the Floy tags are other than insignificant, NMFS would reevaluate their use in the permit. Therefore, the Floy tagging methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in the Hudson River. By extension, Floy tagging is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the Floy tag protocols are closely followed.

Tissue Sample and Expected Response

Immediately prior to each shortnose sturgeon's release, a small sample (1 cm^2) of soft fin tissue would be collected from the trailing margin of the caudal or dorsal fin using a pair of sharp sterilized scissors. This procedure does not harm shortnose sturgeon and is common practice in fisheries science to characterize the genetic "uniqueness" and quantify the level of genetic diversity within a population. Tissue sampling does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact. Many researchers have removed tissue samples according to this same protocol with no mortalities; therefore, we do not anticipate any long-term adverse effects to the sturgeon from this activity (Wydoski and Emery

1983) and the methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in the Hudson River. By extension, genetic fin clip sampling is not likely to reduce the viability of shortnose sturgeon as listed under the ESA.

Blood Sampling

Blood would be collected from the caudal veins of up to 40 shortnose sturgeon adults annually for years 1-5. This would be achieved by inserting a hypodermic needle perpendicular to the ventral midline at a point immediately caudal to the anal fin. The needle would be slowly advanced while applying gentle negative pressure with the syringe until blood freely flows into the syringe. Once a blood sample is collected, direct pressure would be applied to the site of to ensure clotting and prevent further blood loss (Stoskopf 1993).

Venipuncture is a simple way of drawing blood from shortnose sturgeon. Venipuncture is non-lethal and is not expected to have any sub-lethal effects (Klinger *et al.* 2003). Effects of drawing blood samples with syringes from the caudal vein of shortnose sturgeon, could include pain, handling discomfort, possible hemorrhage at the site or risk of infection. To mitigate these effects, the needle would be slowly advanced while applying gentle negative pressure to the syringe until blood freely flows into the syringe. Once the blood is collected, direct pressure would be applied to the site of venipuncture to ensure clotting and prevent subsequent blood hemorrhaging (Stoskopf 1993). The site would then be disinfected and checked again after recovery prior to release. Additionally, all of the researchers responsible for obtaining these samples will have received extensive experience in the procedure.

Expected Response to Blood Sampling

As stated above, venipuncture is non-lethal and we do not expect this method to have sub-lethal effects. We acknowledge that pain, handling discomfort, possible hemorrhage at the site or risk of infection could occur, but procedure mitigation efforts (such as pressure and disinfection) lessen those possibilities. We believe that drawing blood in the manner described appears to have little probability of killing shortnose sturgeon or producing sub-lethal effects as long as the procedure is conducted by a qualified veterinarian or experienced biologist.

Therefore, blood sampling as proposed is not likely to reduce the viability of the shortnose sturgeon population in the Hudson River. By extension, blood sampling is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the proposed methodology and proposed mitigation measures are closely followed.

Fin Ray Sample

Up to 200 shortnose sturgeon annually for years 4 and 5 would be collected for age and population analyses. A small section (~1 cm^2 notch), of the leading pectoral fin ray would be collected on sampled fish, and no other invasive procedure (such as gastric lavage or implantation) would be performed on fish undergoing fin ray sectioning. The recommended method requires researchers, using a hacksaw or bonesaw, to make two parallel cuts across the leading pectoral fin-ray approximately 1cm deep and 1cm wide. The blade of the first cut is

positioned no closer than 0.5cm from the point of articulation of the flexible pectoral base to avoid an artery at this location (Rien and Beamesderfer 1994, Rossiter *et al.* 1995, Collins 1995, Collins and Smith 1996). The second cut is made approximately 1cm distally (Everett *et al.* 2003, Fleming *et al.* 2003, Hurley *et al.* 2004, Hughes *et al.* 2005), where a pair of pliers is then used to remove the fin-ray section.

Studies on the effects of fin-ray sampling have progressed throughout the years. Results have fluctuated and indicate mortality, abnormal enlargement of secondary fin-rays, and no significant differences in swim ability or growth. Kohlhorst (1979) first reported potentially deleterious effects of pectoral fin-ray sampling, including mortality, associated with fin-ray removal from white sturgeon during a mark recapture study. However, the mortality noted by Kohlhorst could have been influenced by small sample size. Nevertheless, the concern of mortality triggered additional laboratory research by Collins (1995) and Collins and Smith (1996). Using methods removing the entire ray (as opposed to a small section) from the base, Collins and Smith found that wounds healed quickly and the pectoral fin-rays behind the leading spine "bulked up" (growing in circumference) and later appeared similar to the original fin-ray. Further, there were no significant differences in growth or survival between treatment and control sturgeon. In other laboratory studies testing fin-ray function, Wilga and Lauder (1999) concluded that pectoral fins are used to orient the body during rising or sinking, but are not used during locomotion. Following Wilga and Lauder's discovery, Parsons *et al.* (2003) removed pectoral fin-rays from shovelnose sturgeon and placed the fish in tanks to test sturgeons' ability to hold position in currents. Without fin-rays, sturgeon were able to hold their positions in a current as well as the control sturgeon. Most recently, while conducting mark and recapture surveys of Atlantic and shortnose sturgeon, Collins *et al.* (2008) discovered that some secondary fin-rays on larger mature sturgeon had enlarged abnormally when the sturgeon were recaptured (after having their entire fin-ray removed). It was thought this growth could potentially be detrimental to the affected sturgeons' health when removing the entire fin-ray. At this point, Collins' team decided to no longer remove entire fin-rays from adult sturgeon, reasoning that this condition was related to slower growth in larger adult fish.

Despite some difficulties documented in age validation of sturgeon (especially for older mature fish) (Rien and Beamesderfer 1994, Paragamian and Beamesderfer 2003, Hurley *et al.* 2004, Whiteman *et al.* 2004), age determination using marginal fin-rays could be a viable, non-lethal means to obtain necessary information on growth, recruitment, and mortality of shortnose sturgeon when generating population estimates, and is also valuable when detecting a shift or bottle-neck in recruitment. Although original procedures resulted in some mortality, modern research shows no difference in growth or swimming ability between controls and sampled fish; at most, modern research shows that secondary fin-rays could enlarge abnormally in larger mature sturgeon.

Expected Response to Fin Ray Sample

The fin-ray sampling procedure would be expected to cause short-term discomfort to individuals, but it is not expected to have a significant impact on the survivability or the normal behavior of individuals. To minimize adverse effects, the samples would be collected using sterilized surgical instruments to remove the 1 cm sections of pectoral fin-rays while fish are under

anesthesia and the entire fin-ray would not be removed. Additionally, no other research method requiring anesthesia (e.g., gastric lavage, or tag implanting) would be conducted on the same fish selected for fin-ray sectioning. Finally, each researcher authorized to conduct fin-ray sectioning would be required to have had training in the procedure. Therefore, the methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in the Hudson River. By extension, fin ray sampling is not likely to reduce the viability of shortnose sturgeon as listed under the ESA.

Anesthetic

Each sturgeon prepared for surgery for procedures requiring anesthetization would be placed in a water bath solution containing buffered tricaine methane sulfonate (MS-222) for anesthetization (Summerfelt and Smith 1990). Concentrations of MS-222 of 50 up to 150 mg/L would be used to sedate sturgeon from induction to a maintenance state of surgical anesthesia for implantation surgery (total loss of equilibrium, no reaction to touch stimuli, cessation of movement, except for opercula movement). Concentrations of MS-222 of up to 50 mg/L would be used to sedate surgeon for gastric lavage.

Because MS-222 is acidic and poorly absorbed, resulting in a prolonged induction time, Sodium bicarbonate (NaHCO3) would be used to buffer the water to a neutral pH. MS-222 is a recommended anesthetic for sturgeon research when used at correct concentrations (Moser *et al.* 2000, USFWS 2008; *but see* Henyey *et al.* 2002, preferring electronarcosis to MS-222). It is rapidly absorbed through the gills and its mode of action is to prevent the generation and conduction of nerve impulses with direct actions on the central nervous system and cardiovascular system. Lower doses tranquilize and sedate fish while higher doses fully anesthetize them (Taylor and Roberts 1999). In 2002, MS-222 was FDA-approved for use in aquaculture as a sedative and anesthetic in food fish (FDA 2002).

Increased concentrations for rapid induction are recommended for sturgeon followed by a lower maintenance dose concentration. Matsche (2011) evaluated MS-222 as a surgical anesthetic for Atlantic sturgeon and found small induction doses to result in bradychardia, near medullary collapse, elevated signs of stress (plasma cortisol and reddening of the skin) and a generalized hemo-concentration consisting of erythrocyte swelling and increased protein and monovalent ion concentrations. Therefore, Matsche concluded that larger, more rapid induction doses with higher concentrations of MS-222 result in reduced signs of physiological stress.

Another risk associated with employing MS-222 to anesthetize sturgeon is using concentrations at harmful or lethal levels. Studies show short-term risks of using MS-222 to anesthetize sturgeon other than shortnose, but show no evidence of irreversible damage when concentrations are used at precise recommended levels. A study on steelhead and white sturgeon revealed deleterious effects to gametes at concentrations of 2,250 to 22,500 mg/L MS-222, while no such effects occurred at 250 mg/L and below (Holcomb *et al.* 2004). Another study did not find MS-222 to cause irreversible damage in Siberian sturgeon, but found MS-222 to severely influence blood constituents when currently absorbed (Gomulka *et al.* 2008; *see also* Cataldi *et al.* 1998 for Adriatic sturgeon).

The above studies show use risks of MS-222 to other sturgeon species, but also show that irreversible damage could be avoided if researchers use proper concentrations. Pertaining to shortnose sturgeon specifically, studies conducted by Haley 1998, Moser *et al.* 2000, Collins *et al.* 2006, 2008 show success with MS-222 at recommended levels (concentrations up to 150 mg/L).

Effects of MS-222 would be short-term and only affect the target species. MS-222 is excreted in fish urine within 24 hours and tissue levels decline to near zero in the same amount of time (Coyle *et al.* 2004). To increase absorption time and ensure a fast anesthesia process, the applicant will add sodium bicarbonate to buffer the acidic MS-222 to a more neutral pH. Therefore, at the proposed rates of anesthesia, narcosis would take one minute and complete recovery time would range from three to five minutes (Brown 1988).

Studies show that recovery from anesthetic stress is more of a concern than the anesthetic itself, which leaves the body in 24 hours. Scientists have examined physiological responses of other fish species to MS-222. MS-222 has increased stress response in rainbow trout (Wagner *et al.* 2003), channel catfish (Small 2003), and steelhead trout (Pirhonen and Schreck 2003), as indicated by elevated plasma cortisol levels (Coyle *et al.* 2004). Additionally, a comparison of steelhead trout controls to MS-222-treated steelhead revealed an anesthetic stress response regarding feed. Steelhead sampled at 4, 24, and 48 hours after MS-222 exposure fed less than their controlled counterparts (Pirhonen and Schreck 2003). These studies indicate sublethal physiological concerns if duration of exposure is not limited.

Expected Response to Anesthetic

Due to the fact that the applicant aims to use an induction concentration up to 150 mg/l within the recommended limitations of MS-222 (which are 50 mg/L for gastric lavage up to 150 mg/l for transmitter implantation and lavage initial sedation) and ensure that fish are anesthetized with a lower maintenance dose of 50 mg/L, NMFS believes that most shortnose sturgeon sedated by MS-222 would be exposed only to minimal short-term risk and should recover to normal. The applicant aims to avoid the possibility of irreversible effects by following concentration recommendations and recovery procedures used in successful shortnose sturgeon diet studies with similar methodologies (Haley 1998, Moser *et al.* 2000, Collins *et al.* 2006, 2008). The applicant has previously been authorized to perform anesthesia under the old permit. Because MS-222 is acidic and poorly absorbed, resulting in a prolonged induction time, Sodium bicarbonate (NaHCO3) would be used to buffer the water to a neutral pH. At the proposed rate, induction time would be approximately three to five minutes and complete recovery times would range from five to six minutes (Brown 1988). MS-222 would be excreted in fish urine within 24 hours and tissue levels would decline to near zero in the same amount of time (Coyle *et al.* 2004). The applicant seems to address stress concerns by limiting duration of anesthesia to three to five minutes and monitoring recovery in boat-side net pens before releasing fish.

Due to our review of available information and the precautions and training applicant has and will take to minimize anesthetic impacts, we believe that MS-222 anesthesia is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be

reached as long as the appropriate concentrations of MS-222 are used and proposed duration exposure and procedures are closely followed.

Gastric Lavage

Gastric lavage on up to 40 shortnose sturgeon taken annually from the Hudson River (years 1-5) would be authorized. Researchers would be using methods described by Haley (1998), Murie and Parkyn (2000), Savoy and Benway (2004), and Collins *et al.* (2008). The applicant has been previously authorized to conduct gastric lavage on shortnose sturgeon with no mortalities or apparent ill effects.

Gastric lavage has recently provided information on diets and how they relate to seasonal foraging and habitat use (Foster 1977, Haley 1998, Murie and Parkyn 2000, Moser *et al.* 2000) and can provide useful information aiding to the designation of critical habitat. Due to the morphology of the shortnose sturgeon gut tract and position of its swim bladder, care must be taken in the procedure to not injure sturgeon while inserting the tube into the esophagus. Potential injury to sturgeon could include abrasion of the gut wall near the pyloric caecum, trauma associated with not introducing the tubing properly in the gut, and potential negative growth responses of sturgeon (going off-feed) after gastric lavage.

To mitigate these risks the applicant proposes to use polyethylene rather than aquarium (rigid) tubing, as the latter type of tubing has produced ruptured bladders and bleeding from the vent (Sprague *et al.* 1993). Additionally, a specific tubing diameter (3.2 mm outside diameter; 2.4 mm inside diameter) will be utilized because it is recommended for sturgeons with total lengths (350 mm FL and above) that will be caught for the study (Collins *et al*. 2008). Finally, the applicant is anesthetizing sturgeon with MS-222 prior to gastric lavage, which relaxes the gut wall. Lavage procedures without anesthesia have revealed constriction of the alimentary canal (Wanner 2006), so anesthetic relaxation should permit easier penetration of tubing to a proper position in the gut.

The gastric lavage procedures associated with the proposed permit amendment would follow methods published by Haley (1998). None of the 46 adult or 2 juvenile shortnose sturgeon or 28 Atlantic sturgeon that Haley (1998) subjected to the procedure died or exhibited adverse responses to the procedure under her methods. In studies utilizing Haley's method modified with the garden sprayer instead of syringe, the same successful results were observed (Collins *et al.* 2006, 2008).

Further review of the literature shows gastric lavage on shortnose sturgeon with Haley's methodology to be a relatively well-tolerated procedure. Moser *et al*. (2000) conducted a study in which they reviewed the most acceptable sampling and handling methods of shortnose and Atlantic sturgeon, including gastric lavage. They concluded the method set forth by Haley (1998) to be a safe and effective technique because of flexible tubing and anesthesia. Savoy and Benway (2004) reported results from 246 shortnose sturgeon collected on the Connecticut River between 2000 and 2003. All of the fish tolerated their procedure well and recovered without apparent stress. M. Collins has also reported zero mortality in the field (M. Collins, pers. com., Nov 2006) on Atlantic sturgeon and shortnose sturgeon. Between 2006 and 2008 Collins *et al.*

(2008) captured and lavaged 198 Atlantic and 20 shortnose sturgeon using Haley's method modified with a garden sprayer. All fish recovered rapidly and were released unharmed after the procedure. The lavage technique was successful in evacuating stomach contents effectively of both Atlantic and shortnose sturgeon of all sizes without internal injury. Additionally, recaptured sturgeon (lavaged an average of 76 days between recapture), experienced typical interim weight gains indicating that the procedure did not negatively influence sturgeon growth. Collins also compared responses of shortnose in captivity to wild fish and found no weight difference from their response to lavage (Collins *et al*. 2006). Of 327 sturgeon collected by Connecticut Department of Environmental Protection investigators from 2000 through 2002, 246 sturgeon were subjected to gastric lavage under Permit No. 1247 (Savoy and Benway 2004). Of these, 17 shortnose sturgeon were subjected to the procedure twice while 2 sturgeon were subjected to the procedure three times. The shortest interval between lavages for a single fish was four days, although the average time between events was 138 days. None of the shortnose sturgeon in that sample died or had physiological or sub-lethal effects that appeared likely to reduce the short- or long-term fitness of the individuals that were exposed to this procedure.

Lavage results on other species of sturgeon (using various methodologies) are similar to the findings of investigators who performed the procedure on shortnose sturgeon. None of the 20 Siberian sturgeon (*Acipenser baeri*) that Brosse *et al*. (2002) lavaged died as a result. However, most of them did experience biologically-significant weight losses for up to 60 days following the procedure. Guilbard *et al.* (2007) followed the methods of Brosse (modified with electric pump) and lavaged Atlantic and lake (*Acipenser fulvescens*) sturgeon with success. Nellis *et al.* (2007) lavaged 41 Atlantic and 98 lake sturgeon using the Guilbard technique, and did not report complications with the procedure. In 2007, Savoy lavaged 41 Atlantic sturgeon using Haley's method with no apparent complication. Shuman and Peters (2006) conducted a pulsed gastric lavage study on shovelnose sturgeon (*Scaphirhynchus platorynchus*) and found no significant difference between their control group and the lavaged group. Wanner (2006) evaluated a gastric lavage method without anesthesia on juvenile pallid sturgeon (*Scaphirhynchus albus*) in which he found no significant difference in condition and growth in length (between the control and lavage groups).

Negative effects reported in the literature on species other than shortnose sturgeon include weight loss, mortality, internal organ injury, and a discontinuation of the lavage procedure altogether. No such effects are described upon literature review for shortnose sturgeon. As stated above, most of the Siberian sturgeon in Brosse's (2002) study did experience biologically significant weight losses for up to 60 days following procedure. Sprague *et al.* (1993) conducted lavage on white sturgeon with rigid aquarium tubing and no anesthesia. These researchers experienced 33% mortality of white sturgeon in the study and also observed ruptured bladders and bleeding from the vent on surviving white sturgeon. Farr *et al*. (2001) quit their lavage procedure on green sturgeon entirely, having been unable to successfully pass tubing past the first bend in the alimentary canal.

Literature review reveals gastric lavage following Haley's (1998) methodology to be tolerated relatively well by shortnose sturgeon. Although death and other complications have occurred in the literature with white, green, and Siberian sturgeon, no such complications have been published for shortnose sturgeon. Experienced gastric lavage researchers working with

shortnose sturgeon such as Haley (1998), Brosse *et al*. (2002), Savoy and Benway (2004), and Collins *et al*. (2006, 2008) have experienced no mortality in the field. Savoy and Benway (2004) even lavaged 17 shortnose sturgeon twice and two shortnose sturgeon three times with no apparent ill effects.

Expected Response to Gastric Lavage

Injuries occurring as a result of gastric lavage in non-shortnose sturgeon studies such as ruptured bladders, bleeding from the vent, and weight loss seem to be addressed by applicants. Ruptured bladders and bleeding from the vent were observed in a study that used rigid aquarium tubing and no anesthesia (Sprague *et al*. 1993). Finally, the weight loss of Siberian sturgeon in Brosse *et al*.'s (2002) study is challenged by the results of Collins *et al*. (2006) (shortnose sturgeon) and Wanner (2006) (pallid sturgeon) showing results that indicate lavage did not negatively influence sturgeon growth.

Applicants would follow successful methods that utilize soft flexible tubing and anesthesia (MS-222), in order to aid tubing down into the gut thereby avoiding bladder rupture and other injury. In order to avoid results of Farr *et al*. (2001) (unsuccessful passage of tubing past first bend in alimentary canal), the applicants have been previously authorized to conduct gastric lavage on shortnose sturgeon and have performed the procedure with no mortalities or apparent ill effects.

Based on our review of available information, training applicant has, and precautions that will be taken to minimize anesthetic impacts, we believe that gastric lavage is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the appropriate protocols are used as proposed.

Acoustic Transmitter Implantation

During the first three years of the study, Lotek acoustic tags would be surgically implanted using anesthesia analyzed above. This would occur on up to 100 shortnose annually for years 1-3. All transmitters would be limited in size to less than 2% of the fish's total weight. Active and passive tracking would follow.

In general, adverse effects of these proposed tagging procedures 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. Choice of surgical procedure, fish size, morphology, behavior and environmental conditions can affect the success of telemetry transmitter implantation in fish (Jepsen *et al*. 2002).

Survival rates after implanting transmitters in shortnose sturgeon are high. Collins *et al*. (2002) evaluated four methods of radio transmitter attachment on shortnose sturgeon. They found 100% survival and retention over their study period for ventral implantation of a transmitter with internally-coiled antenna. Their necropsies indicated there were no effects on internal organs. Dr. Collins in South Carolina (M. Collins, *pers. comm., November 2006*) has also more recently reported no mortality due to surgical implantation of internal transmitters. Devries (2006)

reported movements of 8 male and 4 female (≥ 768 mm TL) shortnose sturgeon internally radiotagged between November 14, 2004 and January 14, 2005 in the Altamaha River. Eleven of these fish were relocated a total 115 times. Nine of these fish were tracked until the end of 2005. The remaining individuals were censored after movement was not detected, or they were not relocated, after a period of 4 months. Periodic checks for an additional 2 months also showed no movement. Although there were no known mortalities directly attributable to the implantation procedure; the status of the 3 unrelocated individuals was unknown (Devries 2006).

Growth rates after transmitter implantation are reported to decrease for steelhead trout. Welch *et al*. (2007) report results from a study to examine the retention of surgically-implanted dummy acoustic tags over a 7 month period in steelhead trout pre-smolts and the effects of implantation on growth and survival. Although there was some influence in growth to week 12, survival was high for animals > 13 cm FL. In the following 16 week period growth of surgically implanted pre-smolts was the same as the control population and there was little tag loss from mortality or shedding. By 14 cm FL, combined rates of tag loss (mortality plus shedding) for surgically implanted tags dropped to < 15% and growth following surgery was close to that of the controls.

Tag weight relative to fish body weight is an important factor in determining the effects of a tag (Jepsen *et al*. 2002). The two factors directly affecting a tagged fish are tag weight in water (excess mass) and tag volume. Perry *et al.* (2001) studied buoyancy compensation of Chinook salmon smolts tagged with surgical implanted dummy tags. The results from their study showed that even fish with a tag representing 10% of the body weight were able to compensate for the transmitter by filling their air bladders, but the following increase in air bladder volume affected the ability of the fish to adjust buoyancy to changes in pressure. Winter (1996) recommended that the tag/body weight ratio in air should not exceed 2%. Tags of greater sized implants produced more mortality of juvenile Atlantic salmon. There was 60% mortality (3 of 5 fish) with a 32-mm implant and 20% mortality (1 of 5 fish) with a 28-mm implant and 20% mortality (1 of 5 fish) with a 24-mm implant (Lacroix *et al*. 2004). Fish with medium and large external transmitters exhibited lower growth than fish with small transmitters or the control group (Sutton and Benson 2003).

Implanted transmitters could affect fish swimming performance. Thorstad *et al*. (2000) studied the effects of telemetry transmitters on swimming performance of adult farmed Atlantic salmon. These researchers found that swimming performance and blood physiology of adult Atlantic salmon (1021-2338 g, total body length 45-59 cm) were not affected when equipped with external or implanted telemetry transmitters compared with untagged controls. There was no difference in endurance among untagged salmon, salmon with small external transmitters, large external transmitters and small body-implanted transmitters at any swimming speed. Authors cautioned that results of wild versus farmed salmon may be different (Peake *et al*. 2007). However, a similar study using sea-ranched Atlantic salmon found no difference in endurance, similar to the farmed salmon study (Thorstad *et al.* 2000). On the other hand, juvenile Chinook salmon < 120 mm FL with either gastrically or surgically implanted transmitters had significantly lower critical swimming speeds than control fish 1 and 19-23 days after tagging (Adams *et al.* 1998).

Implanted transmitters could affect fish growth. Juvenile Chinook salmon with transmitters in

their stomachs (gastrically implanted) consistently grew more slowly than fish with surgically implanted transmitters, fish with surgery but no implanted transmitter, or fish exposed only to handling (Adams *et al*. 1998).

Water temperature has been shown to affect rainbow trout implanted with simulated transmitters. 80 rainbow trout were implanted with simulated transmitters and held at various temperatures for 50 days (10, 15, 20 degrees) (Bunnell and Isely 1999). Transmitter expulsion ranged from 12% to 27% and was significantly higher at 20 degrees C than at 10 degrees C. Mortality ranged from 7 – 25% and was not related to temperature.

Since implantation requires surgery, healing has been described in available information. Several factors can affect obstacles to wound healing in fish including secondary infection and inflammation. Fish epidermal cells at all levels are capable of mitotic division, and during wound healing there is a loss of the intracellular attachments and cells migrate rapidly to cover the defect and provide some waterproof integrity (Wildgoose 2000). This leads to a reduction in the thickness of the surrounding epidermis and produces a thin layer of epidermis at least one cell thick over the wound, however the process can be inhibited by infection (Wildgoose 2000). Thorstad *et al*. (2000) state that incisions were not fully-healed in 13 of the farmed Atlantic salmon with implanted transmitters; two of these had signs of inflammation. Juvenile largemouth bass implanted with microradio transmitters exhibited short-term (5 days) inflammation around the incision and suture insertion points for both non-absorbable braided silk and non-absorbable polypropylene monofilament, but in the longer term (20 days) almost all sutures were shed and the incisions were completely healed (Cooke *et al*. 2003). Chapman and Park (2005) examined suture healing following a gonad biopsy of Gulf of Mexico sturgeon and found both the absorbable and nonabsorbable sutures to effectively sew the skin after biopsy with all sturgeons surviving surgery and incisions healing 30 days after the intervention. Dummy radio transmitters compounded the inflammatory effect silk sutures had on healing incisions compared with inflammation without transmitters (Wagner *et al*. 2000).

The expulsion or rejection of surgically implanted transmitters has been reported from a number of studies, and has been mentioned as an argument for using externally attached transmitters. It does not appear that expulsion causes further complications or death in fish that manifest this occurrence. Such expulsions often occur shortly after tagging and can lead to premature end of studies. Rates of tag shedding and ways of implant exits depend on species, fish condition, tag weight and environmental conditions (Jepsen *et al*. 2002). There are basically three ways of implant exit; through the incision, through an intact part of the body wall and through the intestine. Trans-intestinal expulsion is rare but has been occasionally reported in rainbow trout (Chisholm and Hubert 1985). Five months after tagging, 20% of juvenile Atlantic salmon had expelled their tags through the body wall, adjacent to the healed incision (Moore *et al*. 1990). No mortality or infection occurred as a result of tag expulsion, and fish continued to mature and behave like the control fish. Expulsion occurred in 13 of 22 rainbow trout tagged with dummy tags coated with paraffin wax within 42-175 days after tagging (Chisholm and Hubert 1985). In another study of rainbow trout, three of 21 fish expelled their tags via body wall without subsequent mortality (Lucas 1989). Tag expulsion by juvenile Atlantic salmon during their study occurred but was not a cause of death (Lacroix *et al*. 2004). Two surgically implanted transmitters were also apparently expelled by Atlantic sturgeon (Moser and Ross 1995). In

Kieffer and Kynard's (1993) study, one shortnose sturgeon implanted with a sonic tag rejected its internal tag.

Coating the transmitters has been suggested to vary the rate of expulsion. It has been hypothesized that paraffin coating of the transmitter increases expulsion rate (Chisholm and Hubert 1985). Moser and Ross (1995) reported that retention of surgically implanted tags could be improved for Atlantic sturgeon when the transmitters were coated with a biologically inert polymer, Dupont Sylastic. Additionally, Kieffer and Kynard (*In press*) report that tag rejection internally is reduced by coating tags with an inert elastomer and by anchoring tags to the body wall with internal sutures. Kieffer and Kynard's fish retained tags for their operational life, and in most cases, lasted much longer (mean, 1,370.7 days).

Expected Response to Acoustic Transmitter Implantation

We expect that shortnose sturgeon exposed to internal sonic transmitter implantation would respond in a manner similar to the available information presented above. Survival rates are expected to be high with no ill effects on internal organs expected as a result of the transmitters. We do not expect mortality to occur as a result of this procedure, although a few tagged fish from studies reported above have disappeared and their fate was unknown. We expect that growth rates or swimming performance could be affected and that expulsion of the transmitter could occur, although, there have been no mortalities or infections reported to be associated with expulsion. We expect that the surgical wound would heal normally, but acknowledge that adverse effects of these proposed tagging procedures 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. The research methodologies will minimize these risks, as choice of surgical procedure, fish size, morphology, behavior and environmental conditions can affect the success of telemetry transmitter implantation in fish (Jepsen *et al*. 2002).

PR1 proposes to authorize the use standardized protocols endorsed by NMFS (Kahn and Mohead 2010) which aim to minimize the effects caused by internally implanting transmitter tags. To ensure the sturgeon can endure the weight of these tags, a condition would be imposed stating that the total weight of all transmitters and tags would not exceed 2% of the fish's body weight. By using proper anesthesia, sterilized conditions, and the surgical techniques described above, these procedures would not be expected to have a significant impact on the normal behavior, reproduction, numbers, distribution or survival of shortnose sturgeon and therefore is not likely to reduce the viability of shortnose sturgeon as listed under the ESA.

Incidental Mortality

Incidental mortality of adult or juvenile shortnose sturgeon would be authorized throughout the life of the permit. Specifically, in years 1-3 of the targeted research, 0 incidental mortality will be authorized. In years 4 and 5, however, 2 incidental mortalities per year would be authorized. This is due to the increased fishing effort of applicant in years 4 and 5 of up to 2,000 shortnose sturgeon being captured per year (see Table 1). Applicant would be required to document any lethal takes of shortnose sturgeon by completing a sturgeon salvage form and any specimens of body parts must be preserved until sampling and disposal procedures are discussed with NMFS.

There are currently nine other NMFS-issued permits allowing incidental mortality of juvenile or adult shortnose sturgeon on the eastern seaboard. There is currently one other (No. 1580) NMFS-issued permit allowing incidental mortality for shortnose sturgeon larvae on the Hudson River. Fishing activities also kill shortnose sturgeon incidentally. Commercial and recreational fisheries do not target shortnose sturgeon, although they have some incidental catch. In Connecticut, New York, and Maine, approximately 20 sturgeon are killed annually by commercial and recreational fishing (NMFS 1998).

Taking into consideration that the Hudson River shortnose sturgeon population is the largest extant population of the species (NMFS 1998, Bain *et al.* 2000), NMFS believes that the allowance of up to two incidental mortalities for year 4 and up to two incidental mortalities for year 5, when considering other external incidental mortalities, is unlikely to reduce the viability of the Hudson River population. Therefore, it is unlikely to reduce the viability of shortnose sturgeon as listed under the ESA.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. NMFS is not aware of any future New York State, tribal, local, or private actions in the action area that have a bearing on the risk assessment contained in this Opinion.

CONCLUSION

After reviewing the current status of endangered shortnose sturgeon, the environmental baseline for the action area, the effects of the proposed research program, and the cumulative effects, it is NMFS's biological opinion that the issuance of this permit to Kathryn Hattala, Principal Investigator, of the New York State Department of Environmental Conservation is not likely to jeopardize the continued existence of the endangered shortnose sturgeon. Critical habitat has not been designated for shortnose sturgeon.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the

terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

AMOUNT OR EXTENT OF TAKE

The proposed action requests directed take of shortnose sturgeon in the Hudson River and NMFS does not expect any other listed species to be taken incidentally to this research. The proposed action would allow for up to two incidental mortalities of shortnose sturgeon in year 4 and up to two incidental mortalities of shortnose sturgeon in year 5 of the proposed directed research effort.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The following conservation recommendations would provide information that would improve the level of protections afforded in future consultations involving proposals to issue permits for research on the endangered shortnose sturgeon:

1. *Estimation of incidental mortality rates via capture by effort.* PR1 consistently requests incidental mortalities for shortnose sturgeon during research activities. Incidental mortalities of adult and juvenile sturgeon have been requested mostly for MS-222 anesthesia, gastric lavage, and netting/capture methods. PR1 consistently tracks mortalities during netting/capture. In the future, it would be beneficial to have incidental mortality tracked in the same way for MS-222 and gastric lavage if PR1 is not already doing so. In addition, it would be helpful to track mortality on some per unit effort basis, so that NMFS may be more methodical in the numbers of incidental shortnose sturgeon mortalities authorized for directed research and. The results of this tracking should be provided to F/PR3 for use in the consultations of future research activities.

REINITIATION NOTICE

This concludes formal consultation on the proposed permit to Kathryn Hattala of the New York State Department of Environmental Conservation (Permit No. 16439) pursuant to the provisions of section 10 of the Endangered Species Act. Reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of allowable take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered

in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

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