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 Permits, Conservation and Education Division's proposal to issue a Permit (Number 15614) to Tom Savoy, Connecticut Department of Environmental Protection, Marine Fisheries, for research on shortnose sturgeon in the Connecticut, Thames, and Housatonic Rivers, Connecticut, pursuant to section 10(a)(1)(A) 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: _____

Date: MAY 19 2011

Section 7(a)(2) of the Endangered Species Act of 1973 as amended (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 amendment to Permit Number 15614, the most current shortnose sturgeon 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 (OPR).

CONSULTATION HISTORY

This consultation examines the NMFS' Office of Protected Resources – Permits, Conservation and Education Division's (PR1) authorization of proposed permit 15614 to conduct scientific research activities on shortnose sturgeon in the Connecticut, Thames and Housatonic Rivers. On February 11, 2011, PR1 sent an initiation package to the NMFS' Office of Protected Resources – Endangered Species Division (PR3) for permit 15614, and on February 11, 2011, PR3 initiated consultation.

BIOLOGICAL OPINION

I. DESCRIPTION OF THE PROPOSED ACTION

The proposed action addressed in this Opinion is PR1's authorization of permit 15614 to Tom Savoy, Connecticut Department of Environmental Protection, Marine Fisheries. The authority for PR1's permit issuance is section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq*.). The proposed activities involve purposeful harassment, harm, wounding, trapping, capture, or collection ("take[1]") of endangered shortnose sturgeon (*Acipenser brevirostrum*) for scientific purposes.

The purpose of the activities proposed under permit 15614 is to gather information to help inform conservation management decisions to recover shortnose sturgeon in Connecticut waters and to continue to monitor the status of the Connecticut, Thames and Housatonic River populations by capturing and tracking previously (and newly) acoustic-tagged shortnose sturgeon. The permit would be valid for five years from the date of issuance and would authorize the permit holder to monitor the status of shortnose sturgeon in Connecticut waters. A total of 500 shortnose sturgeon would be captured annually during the study - 450 from the Connecticut River and 50 from the Thames and Housatonic Rivers. In the Connecticut River between river kilometers 0 and 140, 450 fish would be captured via gillnet and trawl, measured, weighed, PIT tagged, have a pectoral fin ray removed, and released. A subset (100) of those 450 would also be gastric lavaged, and another subset (25) of those 450 would also have a sonic/radio tag attached. In either the Thames or Housatonic Rivers, 50 fish annually would be captured via gillnet and trawl, measured, weighed, PIT tagged, fin ray clipped, and released. The proposed take is summarized and broken down in Table 1 as follows.

1 The ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The term "harm" is further defined by regulations (50 CFR §222.102) as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering."

Table 1: Activities proposed to be authorized for endangered shortnose sturgeon (*Acipenser brevirostrum*) research in the Connecticut, Thames, and Housatonic Rivers under Permit No. 15614.

SPECIES	LIFESTAGE	SEX	NUMBER OF ANIMALS PER YEAR	TAKE ACTION	LOCATION
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	275	Capture*; Handle; Measure; Weigh; PIT tag; Sample, fin clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	100	Capture*; Handle; Measure; Weigh; PIT tag; Lavage; Sample, fin ray clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	50	Capture*; Handle; Measure; Weigh; PIT tag; Sample, fin clip; Sample, fin ray clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	25	Capture*; Handle; Measure; Weigh; Instrument, internal (e.g., VHF, sonic); PIT tag; Sample, fin ray clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	50	Capture*; Handle; PIT tag; Sample, fin ray clip	Thames and Housatonic Rivers, CT

* Capture methods include gillnets and trawls

Capture (Adults or Juveniles)

Up to a total of 500 juvenile and/or adult shortnose sturgeon would be captured annually using a standardized netting protocol with anchored gillnets set to fish from the bottom 1.8m of the water column in depths from 10-60 feet. Drift gillnets would also be used, set on the bottom perpendicular to the prevailing flow and allowed to move with the prevailing flow for 15-60 minutes. Gillnet mesh size would range from 10-18cm (stretch measure) and be 30.5m long by 1.8m deep. Gillnets would be set in the main body of the Connecticut River from March through December. Sampling with gillnets would not take place in the tributaries in the cold winter months, as previous studies have indicated that shortnose sturgeon do not utilize these areas. All sampling and handling of sturgeon would be conducted following the guidelines established in "A Protocol for the Use of Shortnose and Atlantic Sturgeon" (Moser *et al.* 2000), and as further amended by NMFS in "A Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons" (Kahn and Mohead 2010).

The following net-set protocol summarized below in Table 2 would be employed. All gillnets would be attended during daylight hours to avoid marine mammal and sea turtle interactions, and in waters having minimum dissolved oxygen (D.O.) concentrations no less than 4.5 mg/L. Netting would cease above 28°C water temperature after consultation with NMFS PR.

Table 2: Summary of Gillnetting Conditions

Water Temperature (^{O}C)	Minimum D.O. Level (mg/L)	Maximum Net Set Duration (hr)
$\leq$ 15	4.5	14
15 $\leq$ 20	4.5	4
20 $\leq$ 25	4.5	2
25 $\leq$ 28	4.5	1
>28		Cease netting until consulting with NMFS

In addition to gillnets, small skiff trawls (5.1 or 8cm mesh, 10m headrope) would also be utilized in sampling the mainstem Connecticut River. Trawls would be towed along the bottom at speeds between approximately 1-2.5 knots for 5-10 minutes using a boat equipped with a small (5.2 or 6.4hp) outboard engine. Trawls would be set and hauled by hand. Trawls would be used year round, as previous reports for the area indicate good success capturing sturgeon using trawls in the late spring and early summer months. Trawls would also be used from December through March (water temperatures < 10°C) when gillnets are not generally used.

Handling

Upon hauling gear, all sturgeon would be individually removed from the gear and placed into a floating net pen attached to the boat or placed in a live well in the boar equipped with a flow-through water system. Shortnose sturgeon would then be processed one at a time in a water-filled measuring box (140x30x25cm); "Stress Coat" would be added to the water to replace the natural slime coat. Fish would be held in the 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. The total time required to complete routine handling and tagging (*i.e.*, PIT tagging, measuring, weighing) would be approximately one minute. Shortnose sturgeon undergoing other procedures would be returned to the net pen until all other sturgeon are processed. No specimen would be held in captivity (i.e., the net pen) for longer than 30 minutes.

PIT Tags

All captured shortnose sturgeon would be scanned with a PIT tag reader. All untagged fish (≥300mm TL) would be tagged with a PIT tag (BioMark TX1411SST 134.2 kHz, 12.5x2.07mm) injected under the skin on the left side of the body, immediately anterior to the dorsal fin and posterior to the dorsal scutes with a 12 gauge hypodermic needle and syringe. No juvenile fish captured less than 300 mm (TL) would be PIT tagged.

Anesthetizing

Each sturgeon prepared for surgery for procedures requiring anesthetization — laparoscopy, transmitter implantation, or fin-ray sectioning — 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 up to 100 mg/L would be used to sedate sturgeon to a state of surgical anesthesia (total loss of equilibrium, no reaction to touch stimuli, cessation of movement, except for opercula movement). The resulting time required for anesthetization and recovery would vary depending on the existing water temperature and water quality (Small 2003, Coyle *et al.* 2004); however, once anesthesia is administered, sturgeon would be continuously monitored and checked for signs of proper sedation by squeezing the tail and gauging the fish's movement and equilibrium, while also checking for steady opercula movement. Just prior to procedures requiring anesthetizing, sturgeon would be removed from the anesthetic to a moist surgery rack where respiration would be maintained by directing fresh ambient water pumped across the gills with tube inserted in the animal's mouth. After surgery, sturgeon would be allowed to recover to normal swimming behavior in boat-side net pens prior to release.

Acoustic Tags

Annually, a maximum of 25 adult or juvenile shortnose sturgeons would be fitted for internal implantation of sonic transmitters tags. There are three types of internal VEMCO tags which would be used. The first type of internal tag (Vemco V13 1H) measures 36mm in length and 13mm in diameter and weighs 6g in water (11g air weight). The other two types of tags would be coded tags with sensor options (e.g., depth or temperature sensing), VEMCO models V13P and V13T 1H are longer than the V13 1H, (13x45mm) and weigh 6g and 12g in water and air, respectively. Fish would be tracked passively with a Vemco array of remote VR2W receivers positioned in the river to document movement within the river. All transmitters would be limited in size to less than 2% of the fish's total weight.

- <u>Internal transmitters</u> would be implanted in adult shortnose using the following 3-5 minute surgical procedure:
    i. Adult or large sub-adult shortnose sturgeon would be captured using gillnets or trawls for implanting telemetry tags;
    ii. Captured fish would be anesthetized using MS-222;
    iii. Anesthetized fish would be held on their backs (i.e., ventral side up) in the holding box while held motionless under narcosis. Water levels would be adjusted to maintain water over the gills. The incision site, approximately 10cm posterior to the pectoral girdle and just lateral of the midline, would be disinfected with Iodine and a surgical opening of 4 cm would then be made in the belly of the fish. A separate sterile surgical packet, containing all surgical instruments and supplies, would be used for each individual fish;
    iv. Once the incision has been completed, a sterilized sonic transmitter coated with bee's wax or Silastic to reduce foreign body rejection (Summerfelt and Mosier 1984) would be inserted and pushed posterior into the surgical opening;
    v. The incision would then be closed with non-absorbable suture in a cruciate pattern (Matsche and Bakal 2008) and swabbed with iodine; and

vi. The fish would then be allowed to recover (to equilibrium) upright in a flow-through water system and released once active.

Genetic Fin Clip

Immediately prior to 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 samples would be preserved in individually labeled vials containing 95% ethanol. The collected genetic tissue samples would be sent for archival to Julie Carter of the NOAA/NOS Laboratory, Charleston, South Carolina, or sent to other genetic specialists authorized to do genetic typing of tissue samples. Proper certification, identity, and chain of custody for the tissue samples would be maintained as samples are transferred.

Fin Ray Sample

A total of 225 shortnose sturgeon annually (no more than 1,125 total for the five year permit) 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 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. The ray section is 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 are then mounted using any number of materials including clear glue, fingernail polish, cytosel, or thermoplastic cement. The annuli are then read using stereoscopic readers.

Gastric Lavage

Up to 100 shortnose sturgeon annually would be taken from the Connecticut River (not exceeding a total of 500 during the life of the permit) for a gastric lavage procedure using methods described by Haley (1998), Murie and Parkyn (2000), Savoy and Benway (2004), and Collins *et al.* (2008). The researchers have previously been authorized to conduct gastric lavage on shortnose sturgeon (File No. 1247) and have performed the procedure on 246 shortnose sturgeon from 2000-2002 (Savoy and Benway 2004) with no mortalities or apparent ill effects.

The method of lavage would include a sedation dose of anesthetic (100 mg/L of MS-222) to relax the fish and alimentary canal prior to the procedure. Variable sized flexible polyethylene tubes, depending on the size of the sturgeon, would be passed carefully through the sturgeon's

alimentary canal and verified to be properly positioned in the stomach by feeling the tubing from fish's ventral surface. Gastric lavage would be then be carried out by gently flooding the stomach cavity with water delivered from a low pressure hand pump. To minimize stress, sturgeon between 250 mm and 350 mm (FL) would be lavaged using 1.90 mm outside diameter (O.D.) tubing; sturgeon between 350 mm to 1250 mm, would be lavaged with a 4.06 mm O.D. tube; and sturgeon above 1250 mm would be lavaged with flexible tubing of 10.15 mm O.D. Prey items dislodged from the stomachs of sampled sturgeon would be collected by a 0.5mm sieve, preserved (using 95% ethanol), and identified later in the laboratory. Fish would then be allowed to recover within a floating net pen alongside the boat prior to release back to the river. The entire procedure, including anesthetizing, would take from seven to eleven minutes (Collins *et al.* 2008). No other invasive procedure would be performed on fish undergoing gastric lavage.

II. PERMIT CONDITIONS

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

1. The table in Appendix 1 (of the permit) outlines the number of protected species, by species authorized 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 (*e.g.*, still photographs, 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 and audio recordings collected under this permit, including those authorized in Table 1 of Appendix 1 (of the permit), in printed materials (including commercial or scientific publications) and presentations provided the images and recordings are accompanied by a statement indicating that the activity was conducted pursuant to Permit No. 15614. This statement must accompany the images and recordings in all 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 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. *Netting, Holding, and Handling Conditions:*

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

ii. Location (GPS), temperature, dissolved oxygen (D.O.), capture gear used (e.g., mesh size, gillnet, trammel, trawl), soak time, species captured, and mortalities must be measured and recorded (at the depth fished) each time nets are set to ensure appropriate environmental netting conditions are adhered to. This data must be made available to NMFS in annual reports or upon request (Appendix 3 of the permit).

iii. After removal from capture gear, sturgeon must be allowed to recover in floating net pens or in onboard live wells while shielding them from direct sunlight.

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

v. Any shortnose sturgeon overly stressed from capture must be resuscitated and allowed to recover inside net pens or live well; prior to release, it may only be PIT and Floy tagged, weighed, measured and photographed.

vi. Gear must be deployed only in waters where D.O. levels > 4.5 mg/L at the deepest depth sampled by the gear for the entire duration of deployment.

vii. Gillnetting for shortnose sturgeon is regulated by environmental conditions appearing in the Table below.

Table: Summary of Gillnetting Conditions

Water Temperature (^{O}C)	Minimum D.O. Level (mg/L)	Maximum Net Set Duration (hr)
≤15	4.5	14
15 ≤ 20	4.5	4
20 ≤ 25	4.5	2
25 ≤ 28	4.5	1
>28		Cease netting until consulting with NMFS

viii. When fish are onboard the research vessel for processing, the flow-through holding tank must allow for total replacement of water volume every 15 minutes. Backup oxygenation of holding tanks with compressed oxygen is necessary to ensure sturgeon do not become stressed and D.O. levels remain at or above 4.5 mg/L.

ix. The total handling time, including onboard research procedures, must not exceed 15 minutes (not including recovery from anesthesia or a stressed condition).

x. The total holding time of shortnose sturgeon after removal from capture gear must not exceed two hours unless fish have not recovered from anesthesia.

xi. The total holding time of shortnose sturgeon when water temperature exceeds 28ºC must never be longer than 30 minutes.

xii. Netting may take place down to 0ºC; however, below 7ºC and above 27ºC, research procedures must be non-invasive only (e.g., PIT and Floy tag, measure, weigh, photograph, and genetic tissue clip).

xiii. Onboard handling of sturgeon should be minimized, keeping fish in water as much as possible and supporting with a sling or net.

xiv. Capture by Trawl Nets

a. Trawls should be towed at a maximum speed of 5 miles per hour for no more than 10 minutes.

b. A depth sounder must be used to monitor the bottom characteristics. If the net becomes snagged (on bottom substrate, debris, etc.), it must be untangled immediately to reduce stress on the animals.

c. A Global Positioning System (GPS) must be used to determine the coordinates of each tow. Trawling over the same exact location more than once in a 24 hour period is not permitted.

xv. Shortnose sturgeon (and bycatch) must be allowed to recover before they are released to ensure full recovery; and it is recommended, if possible, they be treated with an electrolyte bath (e.g., salt) prior to release to help reduce stress and restore slime coat.

xvi. Sturgeon are extremely sensitive to chlorine; therefore, a thorough flushing of holding tanks with bleach would be required between sampling periods.

b. *Genetic Tissue Sampling*:

i. Care must be used when collecting genetic tissue samples from the soft fin rays of sturgeon (pectoral fins). 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 PI on NOS Permit No. 13599) at the NOAA-NOS tissue archive in Charleston, SC (843) 762-8547. A *Biological Sample Certification, Identification and Chain of Custody Form* (Appendix 4a) must accompany shipments of genetic tissue samples to the NOAA-NOS archive in Charleston, South Carolina. Samples must be submitted between six and twelve months after collection, or when periodically solicited by the Permits Division.

iii. A *Field Collection Report* appearing in Appendix 4b (of the permit) should also accompany multiple genetic tissue samples (hard copy or spreadsheet) when shipping to the archive.

iv. The Permit Holder may not transfer biological samples to anyone not listed in the application without obtaining prior written approval from NMFS. Any such transfer will be subject to such conditions as NMFS deems appropriate.

v. The terms and conditions concerning samples collected under this authorization will remain in effect as long as the material taken is maintained under the authority and responsibility of the Permit Holder.

c. *Tagging Conditions*:

i. PIT tags must be used to individually 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 tags or perform other surgical procedures on juvenile shortnose sturgeon less than 300 mm in length.

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

iv. The rate of PIT tag and Floy tag retention and the condition of fish at the site of tag injection should be documented during the study and results reported to the Permits Division in annual and final reports.

v. 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.

vi. Surgical implantation of internal tags must only be attempted when fish are in excellent condition, and must not be attempted on pre-spawning fish in spring or fish on the spawning ground.

vii. During surgical procedures, instruments must be sterilized or changed between uses.

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

ix. Surgical implantation of internal tags and external sonic tags must not occur when water temperatures exceed 27°C or are less than 7°C.

d. *Anesthetization*:

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

iv. Researchers may use MS-222 at concentrations up to 150 mg/L when anesthetizing shortnose sturgeon to implant sonic transmitters; such solutions must be made fresh daily.

v. Prior to anesthetizing shortnose sturgeon with MS-222, researchers must saturate the solution with dissolved oxygen and buffer it to a neutral pH with sodium bicarbonate.

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

vii. To avoid injury while anesthetizing sturgeon in bath treatments, researchers must use restraint (e.g., netting) to prevent animals from jumping or falling out of the container.

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

ix. While performing a surgical procedure, if sudden reflex reaction from an anesthetized fish is encountered, the Researcher must stop the procedure and evaluate the level of anesthesia before proceeding.

x. Researchers must observe shortnose sturgeon closely during recovery from anesthesia, ensuring full recovery prior to release.

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

xii. MS-222 solutions must be disposed of by using state adopted procedures.

e. *Gastric Lavage*

i. Researchers performing gastric lavage on shortnose sturgeon must first receive supervised training on shortnose sturgeon or another surrogate sturgeon species. The Responsible Party or PI must document training to NMFS prior to the activity.

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.

iv. Researchers may carry out gastric lavage on shortnose sturgeon averaging between 250 mm and 350 mm (FL) using flexible tubing up to 1.90mm outside diameter (O.D.); sturgeon between 350mm and 1,250 mm may be lavaged with tubing up to 4.06 mm (O.D); and sturgeon above 1250 mm may be lavaged with flexible tubing up to 10.15 mm O.D.

v. No other research method requiring anesthesia, (i.e., fin ray sampling, laparoscopy or sonic tag implantation), may be conducted on the same fish selected for gastric lavage.

f. *Sea Turtles*:

(The following condition was suggested by the NMFS NEFSC as a precautionary measure addressing how researchers would handle/resuscitate a sea turtle if one were incidentally captured.)

i. If a sea turtle were incidentally captured during netting, the Permit Holder, Principal Investigator, Co-investigator(s), or Research Assistant(s) acting on the Permit Holder's behalf 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).

g. *Atlantic Sturgeon Interaction*:

i. If an Atlantic sturgeon is incidentally captured, it must be PIT tagged (according to the procedures indicated above), genetically sampled (1 cm^2 pelvic fin clip), and released. NMFS also requests all other netting protocols and research conditions protective of shortnose sturgeon be used by researchers to ensure survival of Atlantic sturgeon during research activities.

ii. The Permit Holder shall report any sturgeon interactions to Northeast Regional Office, NMFS, Kim Damon Randall at 978-281-9300 x 6535; Kimberly.Damon-Randall@noaa.gov. This report must contain: the description of the take, location, and final disposition of the sturgeon (*i.e.*, released in good health, *etc*.).

iii. 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 of the permit).

iv. NMFS requests all Atlantic sturgeon interactions are reported to Lynn Lankshear, (Lynn.Lankshear@noaa.gov or 978-281-9300 x 6535). 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.

Reports

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

   - through the online system at https://apps.nmfs.noaa.gov,
   - by email attachment to the permit analyst for this permit, or
   - 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.

2. Written incident reports related to serious injury and mortality events or to exceeding authorized takes, must be submitted to the Chief, Permits Division within two weeks of the incident. 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 research-related mortality or exceedence of authorized take.

3. An annual report must be submitted to the Chief, Permits Division at the conclusion of each year for which the permit is valid. The annual report describing activities conducted during the previous permit year must follow the format in Appendix 2 of the permit.

4. A final report must be submitted to the Chief, Permits Division within 180 days after expiration of the permit, or, if the research concludes prior to permit expiration, within 180 days of completion of the research. The final report must follow the format in Appendix 2 of the permit.

5. Research results must be published or otherwise made available to the scientific community in a reasonable period of time.

Notification and Coordination

1. The Permit Holder must provide written notification of planned field work to the appropriate Assistant Regional Administrator(s) for Protected Resources at the address listed below. Such notification must be made at least two weeks prior to initiation of a field trip/season and must include the locations of the intended field study and/or survey routes, estimated dates of research, and number and roles (for example: PI, CI, veterinarian, boat driver, safety diver, animal restrainer, Research Assistant “in training”) of participants.

Northeast Region, NMFS, 55 Great Republic Drive, Gloucester, MA 01930; phone (978)281-9328; fax (978) 281-9394; email NER.permit.notification@noaa.gov

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 may be contacted at the address listed above for information about coordinating with other Permit Holders.

Observers and Inspections

1. NMFS may review activities conducted pursuant to this permit. At the request of NMFS, the Permit Holder must cooperate with any such review by:

   a. Allowing an employee of NOAA or other person designated by the Director, NMFS Office of Protected Resources to observe permitted activities; and

   b. Providing all documents or other information relating to the permitted activities.

III. APPROACH TO THE ASSESSMENT

NMFS 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 populations 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., Brandon 1978, Mills and Beatty 1979, Stearns 1992, Anderson 2000). 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 the Species* 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 nongovernmental 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 *American Fisheries Society*, *Google Scholar*, *ScienceDirect*, *BioOne*, *Conference Papers Index*, *JSTOR*, and *Aquatic Sciences and Fisheries Abstracts* search engines. 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 D.O. concentrations) as well as data that does not support that conclusion. 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.

IV. DESCRIPTION OF THE ACTION AREA

The action area includes the portion of the Connecticut River between the Connecticut/Massachusetts state line and the Holyoke Dam (river kilometer 140) in Holyoke, Massachusetts, as well as the Thames and Housatonic Rivers. Sampling in the Housatonic River would take place from the mouth of the river (river kilometer 0) to the base of the dam in Derby, Connecticut. Sampling in the Thames River would take place from the mouth of the river (river kilometer 0) to the base of the Greenville Dam in Norwich, Connecticut.

Figure 1: Map of Action Area[2]

V. STATUS OF THE SPECIES/CRITICAL HABITAT

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

Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Green sea turtle	*Chelonia mydas*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Fin whale	*Balaenoptera physalus*	Endangered

2 http://maps.google.com/maps/ms?ie=UTF8&hl=en&msa=0&msid=117448234896363590256.000495bb65177f6668042&ll=41.557922,-72.537231&spn=2.112748,3.532104&z=8

The following summarizes the biology and ecology of the endangered species in the action area that are relevant to the effects analysis in this Opinion. For more comprehensive treatments of the biology, ecology, and management of shortnose sturgeon, refer to Dadswell *et al.* (1984), Gilbert (1989), the Final Recovery Plan for Shortnose Sturgeon (NMFS 1998), and the Canadian Assessment and Update Status Report on the Shortnose Sturgeon (COSEWIC 2005).

Critical habitat has not been designated for shortnose sturgeon. There are no other critical habitat designations for any other listed species in the action area. Therefore, no further discussion of critical habitat appears in this Opinion.

A. **Listed Resources Not Considered Further in this Opinion**

Sea Turtles

Kemp's ridley (*Lepidochelys kempii*), loggerhead (*Caretta caretta*), and green (*Chelonia mydas*) sea turtles have been observed in Long Island Sound (Morreale *et al.* 1992). New England waters (defined as marine waters north of the Nantucket Lightship, out to the 200 mile limit of the Exclusive Economic Zone, and north to Canadian territory) have been identified as important habitat for sea turtles, particularly for leatherbacks (*Dermochelys coriacea*) and Kemp's ridley turtles (Lazell 1980). The state of Connecticut lists leatherback and Kemp's ridley sea turtles as endangered, and loggerhead and green sea turtles as threatened (www.ct.gov/dep). According to stranding data from Connecticut and Rhode Island from 1987-2001, leatherback sea turtles made up the majority (82.2%) of strandings, followed by loggerheads (15.8%), green (1.4%), and Kemp's ridley (0.7%) (Nawojchik and St. Aubin 2003). However, the "topographical constriction to the entrance of Long Island Sound" has probably led to relatively fewer sea turtle strandings in Connecticut than Rhode Island (Nawojchik and St. Aubin 2003). No sea turtles have been observed by research applicants in more than 20 years of sampling for shortnose sturgeon in Connecticut rivers and waters. In light of these reports, there is potential for interactions between sea turtles and the proposed actions, although the probability is remote due to the applicant's personal observations and the above published accounts. In the unlikely event of a sea turtle interaction during sampling, the permit would require adherence to the measures conditioned in the proposed permit to avoid adverse effects to sea turtles. Therefore, listed sea turtles are not considered further in this Opinion.

Fin Whales

Sightings and strandings of marine mammals in Connecticut waters are generally uncommon and infrequent. Since 1976, there have been very few reported sightings or strandings of whales and dolphins in Connecticut waters. Two fin whales (*Balaenoptera physalus*) were found stranded (1976 and 1983) in Connecticut waters. The applicant has not observed any marine mammals in the action area in more than 20 years of sampling for shortnose sturgeon. Due to these records and the experience of the applicant, the possibility of marine mammal interaction due to the proposed actions is considered unlikely. The reported sightings and strandings occurred in Connecticut waters of Long Island Sound and various harbors, not within the proposed action area. In the unlikely event of a marine mammal sighting during sampling, the permit would require adhere to the measures conditioned in the proposed permit to avoid adverse effects to marine mammals. Therefore, fin whales are not considered further in this Opinion.

B. Status of Species Considered in this Opinion

Species Description, Range-wide 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 describes 20 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 individual shortnose sturgeon move between some of these populations each generation (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 and Androscoggin Rivers. 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 Delaware Rivers (Wirgin *et al.* 2005). Wirgin *et al.* (2005) concluded that rivers separated by more than 400km were connected by very little migration while rivers separated by no more than 20km (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 400km stretch of river 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, and may be transients from the Delaware River via the Chesapeake and Delaware Canal (Skjeveland *et al.* 2000, Welsh *et al.* 2002) or remnants of a population in the Potomac River.

Several authors have concluded that shortnose sturgeon populations in the southern end of the species geographic range are extinct. Rogers and Weber (1994), 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. Rogers and Weber (1995b) also concluded that shortnose sturgeon have become extinct in Georgia's Satilla River.

Table 3: Estimated shortnose sturgeon population densities.

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
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	2006 - 2007	1,049	673 – 6,939	Univ. Maine, 2008 SJ Fernandes - 2008
Kennebec River	ME	1977/1981	7,200	5,046 - 10,765	Squiers *et al.* 1982

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
		2003	9,500	6,942 - 13,358	Squiers 2003
Androscoggin River	ME		7200	5000 - 10,800	Squiers *et al.* 1993
Merrimack River	MA	1989 – 1990	33	18 - 89	NMFS 1998
Connecticut River 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
Connecticut River Below Holyoke Dam		1988 – 1993	895	799 – 1,018	Savoy and Shake 1992,
		1998-2002	-	1,042 - 1,580	Savoy 2004
		2003	-	1,500 - 1,800	Connecticut DEP 2003
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	-	-	
Neuse River	NC	2001-2002	extirpated		Oakley 2003, Oakley and Hightower 2007
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	no data	-	-	

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
ACE Basin	SC	no data	-	-	
Savannah River	SC, GA		1,000 - 3,000		Bill Post, SCDNR 2003
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
		2008	368	244-745	Kirk 2008 NMFS Ann. Report
Delaware River	GA	1988	2,862	1,069 - 4,226	NMFS 1998
		1990	798	645 – 1,045	NMFS 1998
		1993	468	315 - 903	NMFS 1998
		2003-2005	6,320	4,387-9,249	DeVries 2006
Satilla River	GA		unknown	-	Kahnle *et al.* 1998
Saint Marys River	FL		unknown	-	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 4). One captive population of shortnose sturgeon is maintained at the Conte Anadromous Fish Research Center in Massachusetts, which is operated by the United States Fish and Wildlife Service (USFWS). These sturgeon were taken from the Connecticut River population and are currently held by Dr. Boyd Kynard under Permit Number 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. The University of Florida (Gainesville) recently acquired shortnose sturgeon from these hatcheries for research purposes.

Smaller, captive populations that have been developed from these 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 about 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 4: 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 molluscs (Moser and Ross 1995, NMFS 1998) 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 1995b, 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). Adult shortnose sturgeon prefer deep, downstream areas with soft substrate and vegetated bottoms, if present. 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).

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 a shortnose sturgeon in the St. John River in New Brunswick is 67 years (for a female), 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 Delaware 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 the 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 it is still listed as Vulnerable and facing a high risk of extinction based in part on: an estimated range reduction of greater than 30% over the past three generations, irreversible habitat losses, effects of habitat alteration and degradation, degraded water quality and extreme fluctuations in the number of mature individuals between rivers.

Status and Trends of Shortnose Sturgeon Populations. Despite the longevity of adult sturgeon, the viability of sturgeon populations are highly sensitive to juvenile mortality that result in 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 the greatest risk.

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 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.

Shortnose Sturgeon in Connecticut Waters.

Spawning. The spawning of shortnose sturgeon in the Connecticut River has been documented. Taubert (1980) captured reproductively mature shortnose sturgeon in the Holyoke Pool, above the Holyoke Dam of the Connecticut River, and also collected 13 shortnose sturgeon larvae. Spawning habitat was characterized as dominated by gravel, rubble and large boulders (rkm 179 and above). Below Holyoke Dam, an adult female shortnose sturgeon was captured, and had its eggs extracted, fertilized and brought to a lab where fry were reared (Buckley and Kynard 1985b). Radio telemetry studies of shortnose sturgeon below Holyoke Dam have shown reproductively mature sturgeon leaving the spawning area in May when water temperatures were between 11.5-14°C (Buckley and Kynard 1985a).

Foraging. To document foraging habits of sturgeon, Savoy and Benway (2004) examined stomach contents of fish collected in the upper river and estuarine regions of the Connecticut River. Shortnose sturgeon in the estuary preyed upon gammarid amphipods, chironomids, and polycheates, whereas in the upriver area, sturgeon fed on clams, chironomids, and insects. Since shortnose sturgeon in the estuary foraged on a broader variety and greater amount of taxa than sturgeon in the upper river (Savoy and Benway 2004), the authors placed a high importance on unrestricted access to the estuary so that fish could maintain the high condition factors observed by Savoy (2004).

Over-wintering/Migration. Researchers have observed shortnose sturgeon use of the Connecticut River estuary in spring during times of high freshwater outflow, particularly in the form of rapid (up to 40km/day) and directed movement to this area post-spawning (Savoy and Shake 1993, Savoy 2004). In another study, most (21 out of 23) shortnose sturgeon fitted with ultra-sonic transmitters in the Connecticut River moved into the estuary each spring (Savoy

2004). Buckley and Kynard (1985a) also documented downstream movement in the spring from Holyoke Dam to the lower river in post-spawning shortnose sturgeon. Extensive use of the estuary over winter was not observed, rather, adult shortnose sturgeon remained in the upriver, freshwater sites (Savoy 2004). During sampling efforts from October to March, researchers were successful in collecting only a single shortnose sturgeon in the estuary (Savoy and Benway 2004).

VI. 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 in the action area. The following information summarizes the primary human and natural phenomena along rivers in Connecticut that are believed to affect the status and trends of endangered shortnose sturgeon and the probable responses of the shortnose sturgeon to these phenomena.

Bycatch

Directed harvest of shortnose sturgeon is prohibited. In 1998, the Atlantic States Marine Fisheries Commission (ASMFC) imposed a coast-wide fishing moratorium on Atlantic sturgeon until 20 year classes of adult females could be established (ASMFC 1998). NMFS followed this action by closing the Exclusive Economic Zone (EEZ) to Atlantic sturgeon take in 1999. Shortnose sturgeon has likely benefitted from this closure as any bycatch in the fishery targeting Atlantic sturgeon has been eliminated.

Although directed harvest of shortnose sturgeon has been prohibited since 1967, bycatch of this species has been documented in other fisheries throughout its range. Adults are believed to be especially vulnerable to fishing gears for other anadromous species (such as shad, striped bass and herring) during times of extensive migration – particularly the spawning migration upstream, followed by movement back downstream (Litwiler 2001). Additionally, bycatch in the southern trawl fishery for shrimp *Penaeus* spp. was eliminated at 8% in one study (Collins *et al.* 1996).

The 1998 Recovery Plan for shortnose sturgeon lists commercial and recreational shad fisheries as a source of shortnose bycatch. Although shortnose sturgeon are primarily captured in gillnets, they have also been documented in the following gears: pound nets, fyke/hoop nets, catfish traps, shrimp trawls, and hook and line fisheries (recreational).

Bycatch in the gillnet fisheries can be quite substantial and is believed to be a significant threat to the species. The catch rates in drift gillnets are believed to be lower than for fixed nets; longer soak times of the fixed nets appear to be correlated with higher rates of mortalities. In an American shad gillnet fishery in South Carolina, of 51 fish caught, 16% were bycatch mortality and another 20% of the fish were visibly injured (Collins *et al.* 1996).

The National Marine Fisheries Service is currently working with some Atlantic states on 10(a)(1)(B) plans for state fisheries that could have shortnose sturgeon as bycatch. At the present time, Connecticut is not one of those states but this may change in the future if shortnose sturgeon bycatch in Connecticut rivers is found to occur.

Poaching

Although poaching has not been documented in the action area, there is evidence of shortnose sturgeon targeted by poachers throughout their range, and particularly where they appear in abundance (such as on spawning grounds) but the extent of the poaching is difficult to assess (Dadswell 1979, Dovel *et al.* 1992, Collins *et al.* 1996). There have been several documented cases of shortnose sturgeon caught by recreational anglers. One shortnose sturgeon illegally taken on the Delaware River was documented by a New Jersey Department of Fish and Wildlife conservation officer in Trenton New Jersey (NJCOA 2006). Additionally, citations have been issued for illegal recreational fishing of shortnose in the vicinity of Troy, New York on the Hudson River and on the Cooper River in South Carolina.

Poaching has also been documented for other sturgeon species in the United States. Cohen (1997) documented poaching of Columbia River white sturgeon sold to buyers on the U.S. east coast. Poaching of Atlantic sturgeon has also been documented by law enforcement agencies in Virginia, South Carolina, and New York, and is considered a potentially significant threat to the species, but the present extent and magnitude is largely unknown (ASPRT 2008).

Dams and Water Diversion

Dams are used to impound water for water resource projects such as hydropower generation, irrigation, navigation, flood control, industrial and municipal water supply, and recreation. Dams can have profound effects on diadromous fish species by fragmenting populations, eliminating or impeding access to historic habitat, modifying free-flowing rivers to reservoirs and altering downstream flows and water temperatures. Direct physical damage and mortality can occur to diadromous fish that migrate through the turbines of traditional hydropower facilities or as they attempt to move upstream using fish passage devices. The construction of dams throughout the shortnose sturgeon's range is probably the main factor reducing their reproductive success which, in turn, could be the primary reason for the reduction in population size for shortnose sturgeon.

There are more than 1,000 dams in the entire Connecticut River watershed. The States of Vermont, New Hampshire, Massachusetts and Connecticut are included in the watershed. Dams on the Connecticut River watershed within the State of Connecticut include: Leesville Dam (Salmon River), Rainbow Dam (Farmington River), and Enfield Dam (breached). Holyoke and Turners Falls (both in Massachusetts) dams are the first dams on the Connecticut. The Holyoke dam splits Connecticut River shortnose sturgeon into two distinct subpopulations (*see* Table 3).

The Housatonic River also has many dams, some of which include the Shepaug Dam (which forms Lake Lillinonah), the Stevenson Dam (which creates Lake Zoar), and the Derby Dam

(forming Lake Housatonic). The Thames River basin also contains 6 multi-purpose flood control dams. This basin lies principally in the eastern third of Connecticut with small sections extending into south-central Massachusetts and northwestern Rhode Island.

Water Quality and Contaminants

The quality of water in river/estuary systems is affected by human activities conducted in the riparian zone and those conducted more remotely in the upland portion of the watershed. Industrial activities can result in discharge of pollutants, changes in water temperature and levels of D.O., and the addition of nutrients. In addition, forestry and agricultural practices can result in erosion, run-off of fertilizers, herbicides, insecticides or other chemicals, nutrient enrichment and alteration of water flow. Coastal and riparian areas are also heavily impacted by real estate development and urbanization resulting in storm water discharges, non-point source pollution, and erosion. The Clean Water Act regulates pollution discharges into waters of the United States from point sources, however, it does not regulate non-point source pollution.

The water quality over the range of shortnose sturgeon varies by watershed but is notably poorer in the north than in the south. The U.S. Environmental Protection Agency (EPA) published its most recent edition of the National Coastal Condition Report (NCCR III) in 2008, a "report card" summarizing the status of coastal environments along the coast of the United States (USEPA 2008; See Table 5 below). The report analyzes water quality, sediment, coastal habitat, benthos, and fish contaminant indices to determine status. The overall condition of the collective coastal waters of the northeastern United States (Virginia to Maine) is fair-poor. The southeast region of the U.S. (Florida to North Carolina) received an overall grade of fair.

Table 5: Summary of the EPA NCCR III for the U.S. east coast published by the EPA (2008) grading coastal environments. (Northeast region=VA to ME; southeast region=FL to NC)

	Region		
Status Index	**Northeast**		**Southeast**
Water quality	fair		fair
Sediment	Fair-poor		fair
Coastal Habitat	Good-fair		fair
Benthos	poor		good
Fish Tissue	poor		Good-fair
Overall	**Fair-poor**		**fair**

Chemicals such as chlordane, dichlorodiphenyl dichloroethylene (DDE), DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later consumed by benthic feeders, such as macroinvertebrates, and then work their way higher into the food web (e.g., to sturgeon). 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 DO, altering pH, and altering other physical properties of the water body.

Life history of shortnose sturgeon (i.e., long lifespan, extended residence in estuarine habitats, benthic foraging) predispose sturgeon to long-term, repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979, NMFS 1998). However, there has been little work on the effects of contaminants on shortnose sturgeon to date.

Heavy metals and organochlorine compounds accumulate in sturgeon tissue, but their long-term effects are not known (Ruelle and Henry 1992, Ruelle and Keenlyne 1993). High levels of contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Cameron *et al*. 1992, Longwell *et al*. 1992, Hammerschmidt *et al.* 2002, Giesy *et al.* 1986, Mac and Edsall 1991, Matta *et al*. 1998, Billsson *et al.* 1998), reduced survival of larval fish (Berlin *et al.* 1981, Giesy *et al*. 1986), delayed maturity (Jorgensen *et al.* 2003) and posterior malformations (Billsson e*t al.* 1998). Pesticide exposure in fish may affect anti-predator and homing behavior, reproductive function, physiological maturity, swimming speed, and distance (Beauvais *et al*. 2000, Scholz *et al*. 2000, Moore and Waring 2001, Waring and Moore 2004).

Sensitivity to environmental contaminants also varies by life stage. Early life stages of fish appear to be more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976). Dwyer *et al*. (2005) compared the relative sensitivities of common surrogate species used in contaminant studies to 17 listed species including shortnose and Atlantic sturgeons. The study examined 96-hour acute water exposures using early life stages where mortality is an endpoint. Chemicals tested were carbaryl, copper, 4-nonphenol, pentachlorophenal (PCP) and permethrin. Of the listed species, Atlantic and shortnose sturgeon were ranked the two most sensitive species tested (Dwyer *et al.* 2005). Additionally, a study examining the effects of coal tar, a byproduct of the process of destructive distillation of bituminous coal, indicated that components of coal tar are toxic to shortnose sturgeon embryos and larvae in whole sediment flow-through and coal tar elutriate static renewal (Kocan *et al.* 1993).

The Connecticut River Fish Tissue Contamination Study (Hellyer 2006) tested smallmouth bass, yellow perch, white suckers, and sometimes brook trout for levels of mercury, dioxin and furans, coplanar PCB congeners, and chlorinated pesticides and non-coplanar PCBs. Total mercury concentrations in all three species were significantly higher in upstream reaches than in downstream reaches. Coplanar PCB TEQ (International Toxic Equivalents, a standardized measure of toxicity) risk was generally lower in upstream reaches than in downstream reaches, although this varied by fish species and receptors. Dioxin contributed a highly variable percentage of total TEQ risk but constituted a risk to both subsistence and recreational fishers and fish-eating wildlife, even when coplanar PCB TEQs were not included in the risk calculations.

Land Use Practices

The majority of the Connecticut River basin's land is covered by forests (66-85%) followed by agriculture which covers 12-15%, while residential land makes up 5-10% (Carr and Kennedy 2008). The majority of the Housatonic River basin's land is covered by forests, followed by agriculture and residential land, and then open land (Kennedy and Weinstein 2000). The Thames River basin has a similar makeup of agriculture, forest, and urban lands. In the Connecticut, Housatonic, and Thames River basins, nutrient concentrations are substantially higher in streams draining urban areas than in streams draining either agricultural or forested areas within studied land units (Zimmerman *et al.* 1996). Pesticide concentrations show a similar trend. Twenty-seven pesticides or breakdown products were detected in samples collected in urban areas within these three river basins (Garabedian *et al.* 1998). Wastewater-treatment facilities are major sources of nutrients in surface water in urban areas.

The human population of the entire Connecticut River basin is around 2,162,000 based on the 2000 Census, with smaller populations living within the Housatonic and Thames River basins. Major cities along the Connecticut River are Middletown, Manchester, Bristol, and Hartford in Connecticut, and Westfield, Springfield, Northampton, Greenfield, and Orange in Massachusetts. Cities along the Housatonic River include Torrington, Thomaston, Northfield, Plymouth, Waterstown, Naugatuck, Seymour, Ansonia, and Derby, CT. Cities along the Thames River include Groton, Ledyard, Montville, New London, Norwich, and Quaker Hill, CT.

Power Plant Operations.

Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. Currently, there is a Vermont Yankee nuclear power plant on the Connecticut River (Vernon, Vermont). There are many plants on the Housatonic and half a dozen plants on the Thames, including the AES Thames and NRG power plants in Montville and Electric Boat in Groton, Connecticut.

Conservation Measures

Section 303(d) of the Federal Clean Water Act (CWA) requires States to develop a list (303(d) List) of waterbodies for which existing pollution control activities are not sufficient to attain applicable water quality standards and to develop Total Maximum Daily Loads (TMDLs) for pollutants of concern. A TMDL sets a limit on the amount of a pollutant that can be discharged into a waterbody such that water quality standards are met. The state of Connecticut is responsible for developing TMDLs for the action area.

On July 28, 2009, the Connecticut Department of Environmental Protection (CTDEP), the United States Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA) announced that the final Housatonic River Basin Natural Resource Restoration Plan has been adopted by the Natural Resource Trustee SubCouncil. The USFWS

has since begun developing funding agreements with the sponsors of each approved project. There are similar restoration programs for the Thames and Connecticut Rivers. The CTDEP manages many other programs such as the Lake Water Quality Management Program, the Nuisance aquatic vegetation management Program, a Water quality monitoring program, Watershed management, and Tidal wetland restoration projects.

Scientific Research

Shortnose sturgeon have been the focus of field studies since the 1970s. The primary purpose of this research is for monitoring populations and gathering data for physiological, behavioral and ecological studies. Over time, NMFS has issued dozens of permits for takes of shortnose sturgeon within its range for a variety of activities including capture, handling, lavage, laparoscopy, bloodwork, habitat, spawning verification, genetics, aging, and tracking. Research on shortnose sturgeon in the U.S. is carefully controlled and managed so it does not operate to the disadvantage of the species. As such, all scientific research permits are also conditioned with mitigation measures to ensure that the research impacts target and non-target species as minimally as possible.

Range wide, there are 18 active scientific research permits targeting wild shortnose sturgeon populations with similar objectives as proposed by the applicant (Table 6). A Biological Opinion was issued for each of these the permits, including the requirement for consideration of cumulative effects to the species. For each permit, the Biological Opinion concluded that issuance, as conditioned, was not likely to jeopardize the continued existence of the shortnose sturgeon.

Table 6: Existing shortnose sturgeon research permits similar to the proposed action.

Permit No.	Location	Authorized Take	Research Activity
10115 Expires: 8/3/2013	Saint Marys & Saltilla Rivers, FL & GA	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 DART tag, transmitter tag, anesthetize, tissue sample, gastric lavage, collect ELS
1505 Expires: 5/15/2011	S. Carolina Rivers and Estuaries	98 adult/juv. (2 lethal), 200 ELS	Capture, handle, measure, weigh, PIT and DART tag, transmitter tag, anesthetize, laparoscopy, blood collection, tissue sample, gastric lavage, collect ELS

Permit No.	Location	Authorized Take	Research Activity
1542 Expires: 7/31/2011	Upper Santee River Basin, SC	5 adult/juv.; 100 ELS	Capture, handle, weigh, measure, PIT and dart tag, tissue sample, ELS collection
1543 Expires:11/30/2011	Upper Santee River Basin, SC	3 adult/juv.	Capture, handle, weigh, measure, tissue sample
14396 Expires: 12/31/2014	Delaware River and Estuary NJ & DE	100 adult/juv. (1 lethal),	Capture, handle, measure, weigh, Floy tag, PIT tag, tissue sample, anesthetize, ultrasonic tag,
14604 Expires: 4/19/2015	Delaware River and Estuary NJ & DE	1,000 adult/juv (1 lethal) 500 ELS	Capture, handle, weigh, measure, PIT tag, Floy tag, ultrasonic tag, tissue sample, anesthetize, laparoscopy, blood/biopsy collection, collect ELS
1547 Expires:10/31/2011	Hudson River, (Haverstraw & Newburgh), NY	500 adults/juv.	Capture, handle, weigh, measure, PIT & Carlin tag, tissue sample
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 Expires: 1/31/2012	Upper Conn. 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
1516 Expires: 5/15/2011	Lower Conn. River & Estuary., CT	500 adult/juv (2 lethal); 300 ELS	Capture, handle, measure, weigh, PIT tag, sonic/radio tag, gastric lavage, fin ray section, collect ELS
1578 Expires: 11/30/2011	Kennebec River and Estuary, ME	500 adult/juv.; 30 ELS	Capture, handle, measure, weigh, tissue sample, PIT tag, acoustic tag, anesthetize, collect ELS
1595-03 Expires: 3/31/2012	Penobscot River and Estuary, ME	200 adult/juv. (2 lethal); 50 ELS	Capture, handle, measure, weigh, borescope, photograph, tissue sample, blood sample, Carlin tag, PIT tag, anesthetize, transmitter tag, collect ELS
14759 Expires: 8/19/2015	North Carolina Rivers, NC	40 adult/juv.	Capture, handle, measure, weigh, photograph, tissue sample, PIT tag, Floy T-bar tag, transmitter tag
14716 Expires: 9/30/2015	Potomac River, VA and MD	30 adult/juv.; 20 ELS	Capture, handle, measure, weigh, photograph, tissue sample, PIT tag, anesthetize, transmitter tag, collect ELS

Integration of the Environmental Baseline. The above activities within the action area pose threats to its shortnose sturgeon population in the following ways. Many activities cause *death* – definite removal of individual fish from the Connecticut, Housatonic, and Thames River populations – 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.

Activities potentially causing death to individual shortnose sturgeon are bycatch in commercial and recreational fishing, cooling water intakes and power plants, and research. 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. Finally, some NMFS-permitted shortnose sturgeon research projects authorize take of early life stages and allow for 1 incidental shortnose sturgeon mortality throughout the life of the permit.

All of the activities identified 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.

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 D.O. concentration or introduction of waterborne contaminants. D.O. concentrations can be affected by maintenance dredging of Federal navigation channels and other waters. Apart from entrainment, dredging can also change D.O. 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 D.O. 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 D.O. concentrations, can result in sub-lethal effects that may have long-term consequences for small populations.

Other NMFS-permitted research activities could also injure shortnose sturgeon. There are currently 18 research permits authorizing directed take of shortnose sturgeon. Although one gillnetting mortality has been reported recently (June 3, 2010, Delaware River), no other shortnose sturgeon research mortalities have been reported since temperature and D.O. netting protocols were implemented. In addition, shortnose sturgeon could be injured in a way that is not observed or quantified by researchers.

Estimated shortnose sturgeon densities for the Connecticut River appear in Table 7. In the Connecticut River, there are two subpopulations of shortnose sturgeon, which have been separated by the Holyoke Dam for 157 years.

Table 7: Shortnose sturgeon population densities in the Connecticut River.

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
Connecticut River 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
Connecticut River Below Holyoke Dam		2003	-	1,500 - 1,800	Connecticut DEP 2003
		1998-2002	-	1,042 - 1,580	Savoy 2004
		1988 – 1993	895	799 – 1,018	Savoy and Shake 1992

There are no known population estimates for shortnose sturgeon in the Thames and Housatonic Rivers.

VII. Effects of the Proposed Action

Pursuant to Section 7(a)(2) of the ESA, federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed activities authorized by permit 15164 would expose 450 shortnose sturgeon to capture, handling, pectoral fin ray sampling, and PIT tagging. A subset of these fish will also undergo anesthesia, gastric lavage, or

receive a sonic/radio tag. In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed action, the probability of individuals of listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the Assessment* section, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, and lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise and to the listed species those populations represent. The purpose of this assessment is to determine if it is reasonable to expect the proposed studies to have effects on listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

A. Potential Stressors

The assessment for this consultation identified several possible stressors associated with the proposed permitted activities. These include: 1) capture by gillnet or trawl; 2) handling for procedures and measurements; 3) PIT tagging; 4) anesthesia; 5) genetic fin clip; 6) pectoral fin ray sample; 7) gastric lavage; and 8) sonic/radio tagging. All captured shortnose sturgeon would be captured, handled, pectoral fin ray sampled, and PIT tagged. Smaller subsets of these fish would undergo anesthesia for gastric lavage or sonic/radio tagging. Activities are expected to occur in the action area for five years until the permit's expiration. Based on a review of available information, we determined that all potential stressors listed above could pose a risk to shortnose sturgeon. Accordingly, the effects analysis of this consultation focused on all of the potential stressors listed above.

B. Exposure Analysis

Exposure analyses identify the co-occurrence of ESA-listed species with the actions' effects in space and time, and identify the nature of that co-occurrence. The Exposure Analysis identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions' effects and the population(s) or subpopulation(s) those individuals represent.

Table 8 identifies the numbers of shortnose sturgeon that are expected to be exposed annually for five years in the action area under the proposed permit 15164.

Table 8: Activities proposed to authorized for endangered shortnose sturgeon (*Acipenser brevirostrum*) research in the Connecticut, Thames, and Housatonic Rivers under Permit No. 15614.

SPECIES	LIFESTAGE	SEX	NUMBER OF ANIMALS PER YEAR	TAKE ACTION	LOCATION
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	275	Capture*; Handle; Measure; Weigh; PIT tag; Sample, fin clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	100	Capture*; Handle; Measure; Weigh; PIT tag; Lavage; Sample, fin ray clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	50	Capture*; Handle; Measure; Weigh; PIT tag; Sample, fin clip; Sample, fin ray clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	25	Capture*; Handle; Measure; Weigh; Instrument, internal (e.g., VHF, sonic); PIT tag; Sample, fin ray clip	Connecticut River, CT
Sturgeon, shortnose	Adult/ Juvenile	Male and Female	50	Capture*; Handle; PIT tag; Sample, fin ray clip	Thames and Housatonic Rivers, CT

* Capture methods include gillnets and trawls

The time required to complete routine, non-invasive methods (*i.e.*, PIT tagging, measuring, weighing) would be less than two minutes per fish. After capture, fish would be allowed to recover for 10-15 minutes prior to further handling/sampling. The cumulative time required for handling/sampling procedures such as electronarcosis/anesthetizing, telemetry tagging, and fin ray sampling would vary, but would typically average less than 15 minutes per fish. Implantation of sonic/radio tag attachment would take 3-5 minutes. While onboard, all fish would be treated with a slime coat restorative in the onboard live well, and, if anesthetized, or otherwise necessary, placed in a separate net pen to ensure full recovery prior to release.

C. Response Analysis

As discussed in the *Approach to the Assessment* section of this Opinion, response analyses determine how listed resources are likely to respond after being exposed to an action's effects on the environment or directly on listed species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

Capture. Up to a total of 500 juvenile and/or adult shortnose sturgeon would be captured annually using a standardized netting protocol with anchored or drift gillnets. Gillnet mesh size would range from 10-18cm (stretch measure) and be 30.5m long by 1.8m deep. Gillnets would be set in the main body of the Connecticut River from March through December. In addition to gillnets, small skiff trawls (5.1 or 8cm mesh, 10m headrope) would also be employed in sampling the mainstem Connecticut River. Trawls would be towed along the bottom at speeds between approximately 1-2.5 knots for 5-15 minutes using a boat equipped with a small (5.2 or 6.4hp) outboard engine. Trawls would be set and hauled by hand and would be used from December through March (water temperatures < 10°C) when gillnets are not generally used.

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). Hightower *et al*. (2002) experienced one Gulf sturgeon mortality in 1997 with gillnetting and Mason and Clugston (1993) experienced some mortality in their gillnets. 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.

To illustrate, shortnose sturgeon mortality resulting from six similar scientific research permits utilizing gillnetting is summarized in Table 9 below. Mortality rates due to the netting activities ranged from 0 to 1.22%. Of the total 5,911 shortnose sturgeon captured by gill nets or trammel nets, only 23 died, yielding an average incidental mortality rate of 0.39%. However, all of the mortalities associated with these permits were due to high water temperature and low dissolved oxygen (DO) concentrations. Moser and Ross (1995) reported gill net mortalities approached 25% when water temperatures exceeded 28ºC even though soak times were often less than 4 hours.

Table 9: Number and percentage of shortnose sturgeon killed by gill or trammel nets associated with existing scientific research permits.

	Permit Number						
	1051	1174	1189	1226	1239	1247	TOTALS
Time Interval	1997, 1999 – 2004	1999 – 2004	1999, 2001 – 2004	2003 – 2004	2000 – 2004	1988 – 2004	1988-2004
No. sturgeon captured	126	3262	113	134	1206	1068	5909
No. sturgeon died in gill nets	1	7	0	0	5	13	26
Percentage	0.79	0.22	0	0	0.41	1.22	0.44

*Note that this table does not incorporate a recent June 3, 2010 Delaware River shortnose sturgeon mortality, as formal annual reporting has not yet been completed for this permit.

Under separate NMFS Permit No. 1247, between 4 and 7% of the shortnose sturgeon captured died in gillnets prior to 1999, whereas between 1999 and 2005, none of the more than 600 shortnose sturgeon gillnetted died as a result of their capture. Also, in five years, under Permit Number 1189, none of the sturgeon captured died. Under Permit Number 1174, all seven of the reported shortnose sturgeon mortalities occurred during one sampling event. Since 2006, more conservative mitigation measures implemented by NMFS and researchers (e.g. reduced soak times at warmer temperatures or lower D.O. concentrations, minimal holding or handling time), have reduced the effects of capture by gillnetting on sturgeon significantly with no documented mortalities except for a June 3, 2010 Delaware River that was recently reported. To limit stress and mortality of sturgeon due to gillnetting, methods in the proposed research would adopt these more conservative measures for gillnetting (discussed further in the section below). This analysis indicates that, if done in accordance with the NMFS's sturgeon protocols (Moser *et al.* 2000, Kahn and Mohead 2010), gillnetting for shortnose sturgeon could be done with lowered risk of direct mortality.

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. 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 Connecticut, Thames, or Housatonic Rivers. 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.

Handling. Up to 500 shortnose sturgeon would be handled for length and weight measurements and 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 Connecticut, Thames, or Housatonic Rivers. 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 a 12 gauge needle at an angle of 60° to 80° 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, 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 PIT tags sized 12.50 x 2.07 mm 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 Connecticut, Thames, or Housatonic Rivers. 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.

Genetic Fin Clip 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 Connecticut, Thames, or Housatonic Rivers. By extension, genetic fin clip sampling is not likely to reduce the viability of shortnose sturgeon as listed under the ESA.

Fin Ray Sample. A total of 225 shortnose sturgeon annually (no more than 1,125 total for the five year permit) 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 Connecticut, Thames, or Housatonic Rivers. 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 up to 100 mg/L would be used to sedate sturgeon to a state of surgical anesthesia (total loss of equilibrium, no reaction to touch stimuli, cessation of movement, except for opercula movement).

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).

One 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 a concentration up to 100 mg/l within the recommended limitations of MS-222 (which are up to 150 mg/l) and ensure that fish are anesthetized for a short period of time, 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 100 shortnose sturgeon taken annually from the Connecticut River (not exceeding a total of 500 during the life of the permit) is requested in the application. 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 (File No. 1247) and has performed the procedure on 246 shortnose sturgeon from 2000-2002 (Savoy and Benway 2004) 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. Negative 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 (File No. 1247) and have performed the procedure on 246 shortnose sturgeon from 2000-2002 (Savoy and Benway 2004) with no mortalities or apparent ill effects.

Due to our review of available information and the precautions and training applicant has and will take 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.

Internal Sonic Tags. Annually, a maximum of 25 adult or juvenile shortnose sturgeons would be fitted for internal implantation of sonic transmitters tags. There are three types of internal VEMCO tags which would be used. The first type of internal tag (Vemco V13 1H) measures 36mm in length and 13mm in diameter and weighs 6g in water (11g air weight). The other two types of tags would be coded tags with sensor options (e.g., depth or temperature sensing), VEMCO models V13P and V13T 1H are longer than the V13 1H, (13x45mm) and weigh 6g and 12g in water and air, respectively. Fish would be tracked passively with a Vemco array of remote VR2W receivers positioned in the river to document movement within the river. All transmitters would be limited in size to less than 2% of the fish's total weight.

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 Internal Sonic Tags. We expect that shortnose sturgeon exposed to internal sonic transmitter implantation would respond 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).

The 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.

VIII. 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 by 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 expects the natural and human-induced phenomena in the action area will continue to influence shortnose sturgeon as described in the Environmental Baseline. However, it is the combination and extent to which these phenomena will affect shortnose sturgeon that remains unknown.

Future federal actions as well as scientific studies contributing to conservation or recovery of shortnose sturgeon will require consultation under the ESA and such studies are not included in the *Cumulative Effects* section of this Opinion. Sources queried for the information on non-federal activities include the U.S. Census Bureau and Lexis-Nexis news and law online search engine. On Nexis, we reviewed bills passed from 2008-2011 and pending bills under consideration were included as further evidence that actions are reasonably certain to occur. In addition, statutes already in place that continue to provide the authority of state agencies to regulate anthropogenic effects were reviewed. State regulation is critical for future anthropogenic impacts in a region. Pending and existing legislation for the states of Connecticut, Massachusetts, New Hampshire, Rhode Island, and Vermont (all states bordering the rivers of concern) address current and future water supply and water quality concerns; riparian and coastal development; ecosystem, natural resource, and endangered species recovery and protection; soil conservation; and regulation of fisheries and invasive species.

IX. Integration and Synthesis of Effects

As explained in the *Approach to the Assessment* section, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, and lifetime reproductive success. 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 population(s) those individuals represent or the species those populations comprise (Brandon 1978, Mills and Beatty 1979, Stearns 1992, Anderson 2000). As a result, if the assessment indicates that listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment.

The narrative that follows integrates and synthesizes the information contained in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Action* sections of this Opinion to assess the risk the proposed activities pose to shortnose sturgeon. There are known cumulative effects (i.e., from future state, local, tribal, or private actions) that fold into our risk assessment for this species.

The proposed issuance by PR1 of scientific research Permit No. 15164 to Tom Savoy, Connecticut Department of Environmental Protection, Marine Fisheries, for research on shortnose sturgeon, would authorize directed take of shortnose sturgeon in the Connecticut,

Thames, and Housatonic Rivers. The proposed activities under this permit include capture, handling, PIT tagging, genetic tissue sampling, fin-ray sampling, anesthesia, internal attachment of sonic transmitters, and gastric lavage. The *Status of listed resources* section identified the construction of dams throughout the shortnose sturgeon's range as the main factor that probably reduced their reproductive success which, in turn, could be the primary reason for the reduction in population size for shortnose sturgeon. It is evident that, in the Connecticut River, Holyoke Dam has separated shortnose sturgeon into two genetically distinct subpopulations. Other threats to the survival and recovery of shortnose sturgeon include habitat fragmentation and loss, incidental capture in coastal fisheries, possible poaching, water pollution, decreased water quality (low DO, salinity alterations), land use practices, and impingement on intake screens of power plant operations. Reasonably likely future actions described in the *Cumulative effects* section include state legislation to address current and future water supply and water quality concerns; riparian and coastal development; ecosystem, natural resource, and endangered species recovery and protection; soil conservation; and regulation of fisheries and invasive species. The shortnose sturgeon population sizes for the Thames and Housatonic Rivers remain unknown. The shortnose sturgeon population size for the Connecticut River is split by the Holyoke Dam and is estimated to be as follows in Table 10.

Table 10: Shortnose sturgeon population densities in the Connecticut River.

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
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

Permit 15164 would be valid for five years from the date of issuance and would authorize non-lethal sampling methods on up to 500 shortnose sturgeon annually in the Connecticut, Thames, and Housatonic Rivers. Each fish would be captured, handled, weighed, measured, PIT tagged, genetic tissue sampled, allowed to recover, and released. Additionally, a subset of fish from those captured would be anesthetized and either surgically implanted with a transmitter, or would undergo gastric lavage, or would undergo fin-ray sampling.

Although some degree of stress or pain is likely for individual fish captured, handled and tagged, and while tagging and tissue sampling will result in tissue injuries, none of the research procedures are expected to result in mortality or reduced fitness of individuals. Delayed or

aborted spawning for some individual fish is a possibility, but the likelihood is remote given the minimization measures proposed. The proposed permit is not expected to affect these population's reproduction, distribution, or numbers. Because the proposed action is not likely to reduce the these population's likelihood of surviving and recovering in the wild, it is not likely to reduce the species' likelihood of surviving and recovering in the wild.

IX. 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 Tom Savoy, Connecticut Department of Environmental Protection, Marine Fisheries, is not likely to jeopardize the continued existence of the endangered shortnose sturgeon. Critical habitat has not been designated for shortnose sturgeon.

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. *Cumulative Impact Analysis.* Before authorizing any additional permits for activities similar to those contained in the proposed permits, F/PR1 should continue to work with the shortnose sturgeon recovery team and the research community to develop protocols that would have sufficient power to determine the cumulative impacts (that is, includes the cumulative lethal, sub-lethal, and behavioral consequences) of existing levels of research on individuals populations of shortnose sturgeon.

REINITIATION NOTICE

This concludes formal consultation on the proposed permit 15164 to Tom Savoy, Connecticut Department of Environmental Protection, Marine Fisheries, for research on shortnose sturgeon in the Connecticut, Thames and Housatonic Rivers, 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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