

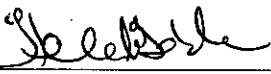
**NOAA's National Marine Fisheries Service
Endangered Species Act Section 7 Consultation**

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 Permit 16306 for research on shortnose sturgeon in Maine, Massachusetts, and New Hampshire Rivers 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 11 2012

Section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. 1531 *et seq.*) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse amendment 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 Act Interagency Coordination 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 of Permit 16306, the most current shortnose sturgeon stock assessment reports, recovery plan, scientific and technical reports from government agencies and the peer-reviewed literature, biological opinions on similar research, and other sources of information.

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

CONSULTATION HISTORY

This consultation examines the NMFS' Office of Protected Resources – Permits, Conservation and Education Division's (PR1) authorization of proposed permit 16306 to conduct scientific research activities on shortnose sturgeon in Maine, Massachusetts, and New Hampshire Rivers. On March 12, 2012, PR1 sent an initiation package to the NMFS' Office of Protected Resources – Endangered Species Act Interagency Cooperation Division (PR5) for permit 16306, and on March 12, 2012, PR5 initiated consultation.

BIOLOGICAL OPINION

I. DESCRIPTION OF THE PROPOSED ACTION

The proposed action addressed in this Opinion is PR1's authorization of permit 16306 to Gail Wippelhauser, Maine Division of Marine Fisheries. The authority for PR1's permit amendment 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 objectives under permit 16306 are characterize migration patterns and habitat preferences, generate population estimates, examine age structure and feeding habits, and otherwise gather key life history information for shortnose sturgeon in the Gulf of Maine and its adjoining coastal rivers.

The research protocols to be utilized under permit 16306 are described in detail in Kahn and Mohead (2010) and are briefly summarized here. The permit would allow Gail Wippelhauser, Maine Division of Marine Fisheries to conduct research March through November, for five years from the date of issuance. The same methodologies would be employed and the same mitigation measures would be in place across all rivers within the action area (the Penobscot, Kennebec, Saco, and Merrimack Rivers, and other small coastal rivers of Maine and New Hampshire). Adult (greater than 500mm total length(TL)) and juvenile (under 500mm TL) shortnose sturgeon would be collected using gill nets, trammel nets, beach seines and trawls. Shortnose sturgeon eggs and early life stage (ELS) fish would be lethally collected using egg mats or D-frame nets. All adult and juvenile shortnose sturgeon would be measured, weighed, passive integrated transponder (PIT) tagged, Floy/T-bar tagged, tissue sampled, boroscoped, photographed, and released. Depending on the research objective to be met, several subsets of captured shortnose sturgeon would be assigned different take activities. One subset of the sturgeon would be additionally be fitted with an internal or external satellite tag; another subset would have an apical spine (or scute) removed; a third subset would be blood sampled; a fourth subset would undergo gastric lavage; and a fifth subset would have a fin ray section removed. As required for the specific procedure, fish would be anesthetized using tricaine methanesulfonate (MS-222) or electronarcosis. The number and procedures to be performed would vary by river (Table 1). In

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 amendment or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering."

addition to the applicant's stated methods, the proposed permit would include language that would minimize impacts to the target animals, non target species, and prevent impacts to bottom habitat.

Table 1: Proposed annual takes of early life stage, juvenile, and adult shortnose sturgeon under Permit No. 16306.

Number of Shortnose Sturgeon	Life Stage	Collection Method	Take Activity	River System
200	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope	Penobscot
30	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, internal or external satellite tag	Penobscot
20	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, apical spine sample [†]	Penobscot
10	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, blood sample	Penobscot
40	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, gastric lavage	Penobscot
35	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, fin ray section	Penobscot
25	Juvenile	Gill Net, Trammel Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample	Penobscot
50	ELS	D-frame Net	Intentional Mortality	Penobscot
400	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope	Kennebec
50	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, internal or external satellite tag	Kennebec

Number of Shortnose Sturgeon	Life Stage	Collection Method	Take Activity	River System
33	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, apical spine sample [†]	Kennebec
10	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, blood sample	Kennebec
40	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, gastric lavage	Kennebec
35	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, fin ray section	Kennebec
25	Juvenile	Gill Net, Trammel Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample	Kennebec
50	ELS	D-frame Net	Intentional Mortality	Kennebec
80	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope	Saco
10	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, internal or external satellite tag	Saco
7	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, apical spine sample [†]	Saco
5	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, blood sample	Saco
20	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, gastric lavage	Saco
10	Adult	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize, fin ray section	Saco

Number of Shortnose Sturgeon	Life Stage	Collection Method	Take Activity	River System
5	Juvenile	Gill Net, Trammel Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample	Saco
10	ELS	D-frame Net	Intentional Mortality	Saco
200	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope	Small Coastal Rivers ME, NH
80	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, tissue sample, boroscope	Small Coastal Rivers ME, NH
20	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, Floy/T-bar tag, tissue sample, boroscope, anesthetize	Small Coastal Rivers ME, NH
185	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, tissue sample, boroscope	Merrimack
20	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, tissue sample, boroscope, apical spine sample [†]	Merrimack
25	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, tissue sample, boroscope, anesthetize, lavage	Merrimack
10	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, tissue sample, boroscope, blood sample	Merrimack
35	Adult/Juvenile	Gill Net	Measure, weigh, photograph, PIT tag, tissue sample, boroscope, anesthetize, fin ray section	Merrimack
100	Juvenile	Trawl Net, Beach Seine, Gill Net, Trammel Net	Measure, weigh, photograph, PIT tag, tissue sample	Merrimack
15	Juvenile	Trawl Net, Beach Seine, Gill Net, Trammel Net	Measure, weigh, photograph, PIT tag, tissue sample, external acoustic telemetry tag	Merrimack
100	ELS	D-frame Net, Egg Mats	Intentional Mortality	Merrimack

[†] Scute sampling would only occur in the event that the apical spine sampling does not provide sufficient samples for elemental analysis. In that case, the apical spine sampling take would be replaced by scute removal after consultation with NMFS PR.

II. PERMIT CONDITIONS

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

1. The tables in Appendix 1 of the permit outline 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.*, photographs, video) as needed to document the permitted activities, provided the collection of such images does not result in takes.
3. The Permit Holder may use visual images and audio recordings collected under this permit, including those authorized in 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 a NMFS Permit. This statement must accompany the images and recordings in all subsequent uses or sales.
4. The Chief, Permits Division may grant written approval for photography, filming, or audio recording activities not essential to achieving the objectives of the permitted activities, including allowing persons not essential to the research (*e.g.*, a documentary film crew) to be present, provided:
 - a. The Permit Holder submits a request to the Permits Division specifying the location and nature of the activity, approximate dates, and number and roles of individuals for which permission is sought.
 - b. Non-essential photography, filming, or recording activities will not influence the conduct of permitted activities or result in takes of protected species.
 - c. Persons authorized to accompany the Researchers for the purpose of such non-essential activities will not be allowed to participate in the permitted activities.
 - d. The Permit Holder and Researchers do not require compensation from the individuals in return for allowing them to accompany Researchers.
5. Researchers must comply with the following conditions related to the manner of taking:

a. Netting Practices with Gillnets:

i. In General:

- (1) The Permit Holder must take necessary precautions ensuring sturgeon are not harmed during captures, including using appropriate gill net mesh sizes and twine types, restricting gill netting activities by decreasing net set durations as water temperature increases and dissolved oxygen concentration decreases, and following other measures outlined in “A Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons” http://www.nmfs.noaa.gov/pr/pdfs/species/kahn_mohead_2010.pdf

ii. Specific Netting Conditions Include:

- (1) Protective of Atlantic salmon, gill nets must not be set within 0.5 miles upstream or downstream of the confluences of the Kennebec River and Bond Brook, and 0.5 miles below Lockwood Dam; Nets must not be set within 0.5 miles upstream or downstream of the confluences of the Penobscot River and Cove Brook, Kenduskeag River, Ducktrap River, or Meadow Brook;
- (2) Researchers must avoid fishing in documented locations of the Penobscot River and Kennebec complex where Atlantic salmon have been encountered in the past (Sand Island @ < 43.914465,-69.727821>; Pine Island @ < 43.914465,-69.727821>; and Fort Halifax Park @ < 44.54482,-69.627271>) and (in shallower, non-channel waters of Oak Point Cove @ 44.667005,-68.822994; and Graham Station @ 44.821459,-68.708721);
- (3) Six inch gillnets may be fished in main channels of rivers and bays of the research area at depths greater than 20 feet at low tide. Nets may also be fished in areas characterized as “mudflats,” off main channels in waters less than 10 feet at low tide;
- (4) To limit snagging nets on bottom structure, a sounding device and Global Positioning System (GPS) is optionally recommended;
- (5) If a net becomes snagged on bottom substrate or debris, it must be untangled immediately while attempting to reduce stress on captured animals; and
- (6) Nets may be fished at water temperatures between 0°C and 26°C and at dissolved oxygen concentrations of 4.5 mg/l (or 55% saturation) or greater during deployment. See summary of environmental conditions below.

Summary of Authorized Netting Conditions for Permit 16306

Water Temperature (°C)	Minimum D.O. Level (mg/L)	Minimum D.O. Saturation (%)	Maximum Net Set Duration (hrs)
0 < 15	4.5	55	14 ¹
0 < 15	4.5	55	6 ²
15 < 20	4.5	55	3 ³
20 ≤ 26	4.5	55	1
> 26	N.A.	N.A.	Cease Netting

1. Unattended overnight deployment of gillnets in freshwater areas of the Merrimack River.
2. Attended deployment of gillnets in daylight hours where nets must be checked every three hours
3. Attended deployment of gillnets in daylight hours where nets must be checked every 1.5 hours.

b. Collecting Eggs/Larvae with Egg Mats/D-nets:

- i. Deployment of egg mats/D-nets is authorized for collecting shortnose sturgeon eggs and larvae up to the limit described in the take table for each river. Eggs may be transported back to the lab for species verification and preservation in 95% ETOH; the remainder must be returned to the river at the site of collection.
- ii. D-nets may be set in suspected spawning areas for a maximum duration of three (3) hour intervals before checking;
- iii. Egg mats/D-nets must be removed from rivers once water temperature exceeds 25°C, reaches 0°C, or the authorized numbers of shortnose sturgeon eggs and/or larvae have been collected, whichever comes first.
- iv. Egg mats must be checked at least twice per week.
- v. No more egg mats must be fished than necessary.

c. Holding:

- i. After removal from capture gear, sturgeon should be recovered in floating net pens or onboard live wells and shielded from direct sunlight. To accommodate larger catches, researchers must carry secondary net pen(s) to avoid overcrowding. Else, researchers must release any excess catch after only PIT and Floy tagging;
- ii. Any shortnose sturgeon showing signs of being overly stressed from capture or otherwise, must be resuscitated and allowed to

recover inside a net pen or live well. Once recovered, it may only be PIT and Floy tagged prior to release;

- iii. The total holding time of shortnose sturgeon after removal from capture gear must not exceed two hours unless fish have not yet recovered from anesthesia;
- iv. When fish are held onboard a research vessel, they must be placed in flow-through tanks allowing for total replacement of water volume every 15-20 minutes. Dissolved oxygen levels in holding tanks must be maintained at or above 4.5 mg/l; and
- v. Tanks used for holding sturgeon onboard must be disinfected with chlorine bleach between sampling periods and thoroughly flushed prior to reuse.

d. Handling:

- i. Handling of shortnose sturgeon for biological sampling (i.e., measuring, weighing, PIT and Floy tagging and tissue sampling) must not exceed 15 minutes;
- ii. While being transferred for sampling, sturgeon must be moved rapidly and supported in sling or net. During transfer they must also be kept shaded and in water to the maximum extent possible;
- iii. Smooth rubber gloves must be worn to reduce abrasion of skin and removal of slime coat; and
- iv. Fish shall be treated with an electrolyte bath prior to release to help reduce stress and restore slime coat.
- v. Prior to release, sturgeon must be examined and, if necessary, recovered by holding fish upright and immersed in river water, gently moving the fish front to back, aiding freshwater passage over the gills to stimulate it. The fish must be released only when showing signs of vigor and able to swim away under its own power. A spotter should watch the fish, making sure it stays submerged and does not need additional recovery.

e. Anesthesia:

- i. NMFS authorizes electronarcosis for inducing anesthesia on shortnose sturgeon using low voltage direct current as described by Henyey et al. (2002). NMFS requests results of its use be included in annual reports;

- ii. Researchers performing electronarcosis must first receive supervised training from a properly permitted individual using either wild or captive shortnose sturgeon, or another surrogate sturgeon species. The Responsible Party or PI must verify such training to NMFS prior to the activity, and then append a signed letter received from NMFS certifying the training;
 - iii. Researchers may use tricaine methane sulfonate (MS-222) to anesthetize shortnose sturgeon, preparing fresh solutions as needed at concentrations up to 150 mg/L;
 - iv. Prior to anesthetizing shortnose sturgeon with MS-222, researchers must saturate the solution with dissolved oxygen and also buffer it to a neutral pH with equal parts of sodium bicarbonate;
 - v. When anesthetizing shortnose sturgeon, researchers must observe animals closely, establishing when the proper level of anesthesia is reached;
 - vi. Only non-stressed animals in excellent health and vigor may be anesthetized;
 - vii. Researchers must observe shortnose sturgeon closely during recovery from anesthesia, ensuring full recovery prior to release;
 - viii. All researchers should wear protective clothing, gloves, and goggles when handling MS-222 powder; and
 - ix. MS-222 solution should be disposed of by using state adopted procedures.
- f. *Biological Sampling (Genetic, Blood, and Scute Samples):*
- i. Care must be used when collecting biological samples. Instruments must be disinfected and gloves must be changed between sampling each fish to avoid possible disease transmission or cross contamination of genetic material;
 - ii. Genetic tissue samples must be taken from all juvenile and adult shortnose sturgeon collected by removing a small (1.0 cm²) fin-clip from soft fin tissues using a pair of sharp scissors. NMFS recommends preserving tissue samples in individually labeled vials containing 95% ethanol;

- iii. Archiving of genetic tissue samples must be coordinated with the NOAA/NOS Tissue Archive in Charleston, South Carolina (843/762-8547). Please refer to Appendix 3a, 3b of the permit for proper certification, identity, and chain of custody maintained during transfer of tissue samples;
 - iv. To perform blood sampling, researchers must first receive supervised training from a properly permitted individual using either wild, captive shortnose sturgeon, or another surrogate sturgeon species. The Responsible Party or PI must report the training to NMFS prior to the activity, and then append a signed letter received from NMFS certifying the training.
 - v. Blood samples may be sent to the cooperating individuals listed in Condition C.1.c for analysis.
 - vi. Blood samples not consumed during testing must be destroyed and properly disposed of immediately after all testing is completed;
 - vii. Scute samples from wild shortnose sturgeon may be taken by removing 4 -10 mm clips of the apical hooks.
 - viii. 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; and
 - ix. The terms and conditions concerning biological 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.
- g. *PIT Tags and Floy Tags:*
- i. Researchers must not insert PIT tags nor perform other surgical procedures on shortnose sturgeon less than 300 mm (TL);
 - ii. Standard 11.5 mm and 14 mm sized PIT tags (having 134.2 kHz frequency) may be inserted in sturgeon of at least 300 mm and 400 mm (TL), respectively;
 - iii. Prior to placement of PIT tags, the entire dorsal surface of each fish must be scanned with a PIT tag reader to ensure detection of fish tagged in other studies. Previously tagged fish must not be retagged;

- iv. PIT tags should be inserted proximal and anterior to the dorsal fin. However, PIT tags may also be inserted at the widest dorsal position just to the left of the 4th dorsal scute, if necessary to ensure tag retention or prevent harm to smaller juvenile sturgeon;
 - v. Numbered Floy tags must be anchored in the dorsal fin musculature base, inserted forward and slightly angled downward from the left to the right side through the dorsal pterygiophores; and
 - vi. The rate of PIT tag and Floy tag retention and the condition of fish at the site of tag injection must be documented during the study and results reported to NMFS in annual and final reports.
- h. Transmitters:
- i. NMFS does not recommend capturing adult sturgeon during upstream spawning migration or on spawning grounds due to the risks of aborted spawning.
 - ii. Transmitter tags may be implanted completely internally or attached completely externally;
 - iii. If research objectives are to track late stage, pre-spawning females, NMFS recommends external attachment² of short term (e.g., 10-12 mo life) transmitters to the dorsal fin during the preceding fall or winter months;
 - iii. Surgery to implant transmitter tags in shortnose sturgeon must occur at water temperatures between 7 and 26° C;
 - iv. The cumulative weight of all transmitters and tags must not exceed 2% (measured in air) or 1.25% (measured in water) of the fish's total body weight; and
 - v. Researchers must document in annual and final reports any information on behavioral adaptation to telemetry tag by tracking individual fish, recording swimming behavior, periods between detections, and number of un-relocated individuals. Additionally, the healing rates of incisions on recaptured fish should be recorded.

² NMFS recommends attaching an external transmitter to the dorsal fin of shortnose sturgeon as highlighted in Kahn and Mohead (2010, p.30)
http://www.nmfs.noaa.gov/pr/pdfs/species/kahn_mohead_2010.pdf

- i. *Endoscopic Examination (Boroscope):*
 - i. Boroscopy for identifying sex/maturity is authorized on adult shortnose sturgeon (≥ 69 cm TL), specifically those not releasing eggs or sperm while handling. Procedures should take place during the foraging season and the overwintering season (May - December); and
 - ii. Prior to an individual researcher performing boroscopy, s/he must first receive supervised training from a properly permitted individual using either wild or captive shortnose sturgeon, or another surrogate sturgeon species. The Responsible Party or PI must report individual training to NMFS prior to the activity, and then append a signed letter received from NMFS certifying the training.

- j. *Gastric Lavage for Diet Analysis:*
 - i. Individual researchers performing gastric lavage must first receive supervised training from a properly permitted individual using either wild or captive shortnose sturgeon, or another surrogate sturgeon species. The Responsible Party or PI must report individual training to NMFS prior to the activity, and then append a signed letter received from NMFS certifying the training;
 - ii. Researchers may carry out gastric lavage via 1.90mm diameter flexible tubing on shortnose sturgeon between 250 mm -350 mm (FL); 4.06 mm diameter flexible tubing may be used on sturgeon between 350 mm-1250 mm (FL); and 10.15 mm flexible tubing may be used on sturgeon over 1250 mm (FL);
 - iii. Prior to gastric lavage, researchers must anesthetize sturgeon allowing relaxation and penetration of the tubing to proper positioning in the gut; and
 - iv. While performing gastric lavage on shortnose sturgeon, researchers must irrigate the sturgeon's gills with ample water flow, insuring respiration.

- k. *Atlantic Salmon Interaction:*
 - i. Should an Atlantic salmon be taken incidentally during netting, researchers must suspend operations immediately and notify NOAA Fisheries Northeast Region Protected Resources Division, David Bean at (207) 866-4172 (David.Bean@noaa.gov) and the

Chief, Permits Division, Office of Protected Resources at (301) 427-8401 within 48 hours of any capture of an Atlantic salmon; and

- ii. An incidentally captured Atlantic salmon must be released back to the river alive; it must be cut free from the net mesh, held in the water to the maximum extent practical.

l. Atlantic Sturgeon Interaction:

- i. If an Atlantic sturgeon is incidentally captured, NMFS requests it minimally be PIT tagged, genetically sampled, and released. NMFS also requests that all other netting protocols and research conditions protective of shortnose sturgeon also be used by researchers to ensure survival of Atlantic sturgeon during research activities; and
- ii. NMFS requests that Atlantic sturgeon parts or carcasses opportunistically collected are reported to Jess Pruden, NMFS-PR (Jessica.pruden@noaa.gov) 978-281-9300 x 6535. The report should describe the take, location, and final disposition of the sturgeon (Permit Appendix 5).

m. Marine Mammal Interactions:

- i. In all boating activities researchers are advised to keep a close watch for all marine mammals to avoid harassment or adverse interaction, and are also advised to review the NMFS Northeast Region Marine Mammal Approach and Viewing Guidelines located online at: http://www.nero.noaa.gov/prot_res/mmv;
- ii. If a marine mammal is sighted during research activity, researchers must turn off boat engines or put them in neutral;
- iii. Researchers must not disturb marine mammals at rest with boating activity, or deploy nets when animals are observed within the vicinity;
- iv. If a marine mammal is observed within the vicinity of planned netting activity, it must be allowed to either leave or pass through the area safely before netting is initiated;
- v. Netting activities must be closely attended and continuously monitored when netting in areas where marine mammal interactions are likely;

- vi. Should a marine mammal enter a research area after nets are deployed, nets must be removed. Netting may resume only after the animal is no longer within a 100-meter radius safety zone, or 30 minutes has elapsed since the mammal was last observed within the safety zone;
 - vii. Researchers should report *any* marine mammal interaction within 48 hours to the Chief, Permits Division and/or the permit analyst at 301-427-8401; and
 - viii. In the unlikely event a marine mammal is captured or harmed, the animal should be assessed, and, if possible, and is safe for the researchers and the animal, the animal should be supported to prevent it from drowning. The NOAA Northeast Region Marine Mammal and Sea Turtle Stranding and Entanglement Hotline should be contacted as soon as possible at (800) 281-9351, as well as the Chief, Permits Division and/or the permit analyst at 301-427-8401.
- n. *Aquatic Nuisance Species:*
- i. To prevent potential spread of aquatic nuisance species identified in the watershed, all equipment assigned to the research must not be reassigned to other watersheds until gear and equipment used is sanitized, rinsed, and dried.
- o. *Mortality:*
- i. In the event of mortality of shortnose sturgeon, Atlantic sturgeon, or Atlantic salmon from directed or incidental take (or found opportunistically), NMFS requests that dead specimens or body parts be photographed, measured, and immediately preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS (Permit Appendix 5).
6. The Permit Holder must comply with the following conditions for biological samples acquired or possessed under authority of this permit.
- a. The Permit Holder is ultimately responsible for compliance with this permit and applicable regulations related to the samples unless the samples are permanently transferred according to NMFS regulations governing the taking, importing, and exporting of endangered and threatened species (50 CFR 222.308).

- b. The Permit Holder must receive written approval from the Permits Division to use samples for purposes not related to the permitted objectives.
- c. Samples must be maintained according to accepted curatorial standards and must be labeled with a unique identifier (e.g., alphanumeric code) that is connected to on-site records with information identifying the:
 - i. species and, where known, age and sex
 - ii. date of collection, acquisition, or import
 - iii. type of sample (e.g., blood, skin, bone)
 - iv. origin (i.e., where collected or imported from)
- d. Biological samples belong to the Permit Holder and may be temporarily transferred to Authorized Recipients without additional written authorization, for analysis or curation related to the objectives of this permit. The Permit Holder remains responsible for the samples, including any reporting requirements.
- e. The Permit Holder may request approval of additional Authorized Recipients for analysis and curation of samples related to the permit objectives by submitting a written request to the Permits Division specifying:
 - i. the name and affiliation of the recipient
 - ii. the address of the recipient
 - iii. the types of samples to be sent (species, tissue type)
 - iv. whether the disposition is analysis or curation
- f. Sample recipients must have written authorization from a NMFS Regional Office prior to permanent transfer of samples and transfers for purposes not related to the objectives of this permit.
- g. Samples cannot be bought or sold, including parts transferred through written authorization by a NMFS Regional Office

Reports

- 1. The Permit Holder must submit annual, final, and incident reports containing the information and in the format specified by the Permits Division.
 - a. Reports must be submitted to the Permits Division by one of the following:
 - the online system at <https://apps.nmfs.noaa.gov>
 - an email attachment to the permit analyst for this permit
 - a hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Room 13705, Silver Spring, MD 20910; phone (301)427-8401; fax (301)713-0376

- b. You must contact your permit analyst for a reporting form if you do not submit reports through the online system.
2. Incident reports: must be submitted within two weeks of serious injury and mortality events or exceeding authorized takes.
 - a. The incident report must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional serious injury and research-related mortality or exceedence of authorized take.
 - b. In addition to the written report, the Permit Holder must contact the Permits Division by phone (301-427-8401) as soon as possible, but no later than within two business days of the incident.
 - c. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.
3. Annual reports describing activities conducted during the previous permit year must:
 - a. be submitted each year for which the permit is valid; and
 - b. include a tabular accounting of takes and a narrative description of activities and effects.
4. A final report summarizing activities over the life of the permit must be submitted by 180 days post expiration, or, if the research concludes prior to permit expiration, within 180 days of completion of the research.
5. Research results must be published or otherwise made available to the scientific community in a reasonable period of time. Copies of technical reports, conference abstracts, papers, or publications resulting from permitted research must be submitted the Permits Division.
6. *A Biological Sample Certification, Identification and Chain of Custody Form* (Permit Appendix 3a) must accompany shipments of genetic tissue samples to the NOAA-NOS archive in Charleston, South Carolina. Samples must be submitted no more than twelve months after collection.
7. *A Field Collection Report* appearing in Appendix 3b of the permit should also accompany multiple genetic tissue samples (hard copy or spreadsheet) when shipping to the NOAA-NOS archive.

8. The following information should be measured and recorded (at the depth and for the duration nets are fished), ensuring appropriate values according to the conditions above: temperature, dissolved oxygen, net used (*i.e.*, mesh size), soak time, species of fish captured, and any mortalities occurring. NMFS request this data (Permit Appendix 4) be made available in annual reports or periodically upon request.
9. Specimens or body parts of dead shortnose or Atlantic sturgeon or Atlantic salmon 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 (Permit Appendix 5).
10. NMFS requests all Atlantic sturgeon interactions are reported to Lynn Lankshear, NMFS-PR (Lynn.Lankshear@noaa.gov or 978-281-9300 x 6535) as soon as practical. If dead specimens are collected, this report should be documented by completing the sturgeon salvage form (Permit 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.

Notification and Coordination

1. The Permit Holder must provide written notification of planned field work to the applicable NMFS Region at least two weeks prior to initiation of each field trip/season. If there will be multiple field trips/seasons in a permit year, a single summary notification may be submitted per year.
 - a. Notification must include the
 - i. locations of the intended field study and/or survey routes
 - ii. estimated dates of activities
 - iii. number and roles of participants (for example: PI, CI, veterinarian, boat driver, safety diver, animal restrainer, Research Assistant “in training”)
 - b. Notification must be sent to the following Assistant Regional Administrator for Protected Resources:

Northeast Region, NMFS, 55 Great Republic Drive, Gloucester, MA 01930;
phone (978)281-9328; fax (978)281-9394
Email (*preferred*): 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. Contact the applicable Regional

Office(s) listed in F.1.b for information about coordinating with other Permit Holders.

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 dissolved oxygen 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 areas is defined in 50 CFR 402.2 as “all areas to be affected directly or indirectly by the Federal Action and not merely the immediate area involved in the action.” The proposed research would take place in the waters of the Gulf of Maine, the Penobscot, Kennebec, and Saco Rivers in Maine, the Merrimack River in Massachusetts, and other small coastal rivers of Maine and New Hampshire (Figures 1-2).

Figure 1: Proposed Action Area for Permit 16306; shows sampling that would occur in the Penobscot, Kennebec, and Saco Rivers in Maine.

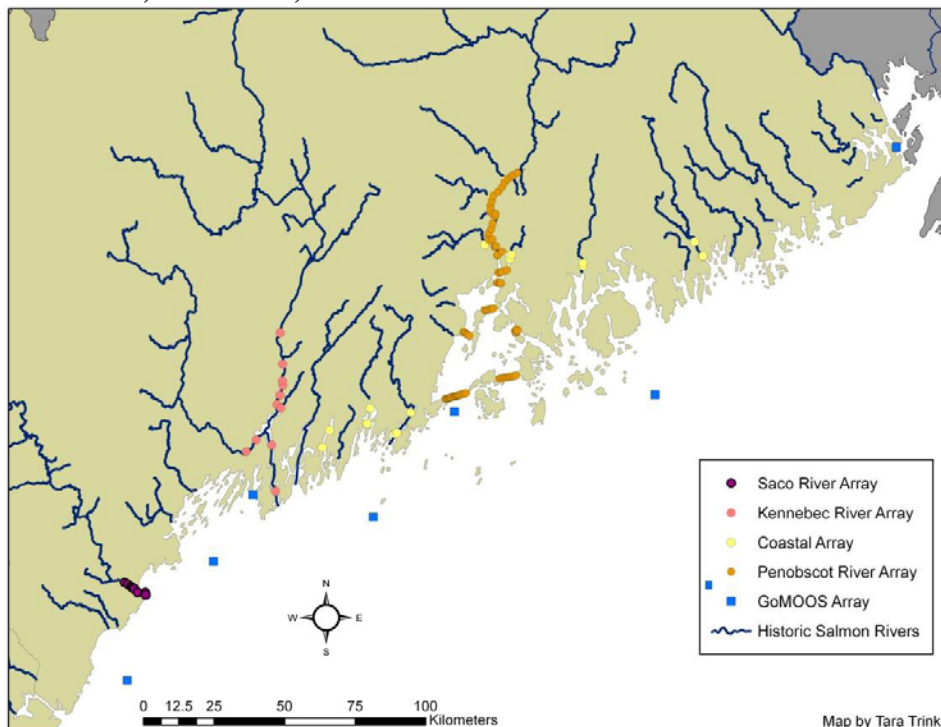


Figure 2: Proposed Action Area for Permit 16306; shows sampling that would occur in the Merrimack River, Massachusetts.



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	<i>Acipenser brevirostrum</i>	Endangered
Atlantic sturgeon, Gulf of Maine (GOM) Distinct Population Segment (DPS)	<i>Acipenser oxyrinchus oxyrinchus</i>	Threatened
Atlantic salmon, GOM DPS	<i>Salmo salar</i>	Endangered
Loggerhead sea turtle	<i>Caretta caretta</i>	Threatened
Kemps’s ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Endangered
Green sea turtle	<i>Chelonia mydas</i>	Threatened
Northern Right whale	<i>Eubalaena glacialis</i>	Endangered
Fin whale	<i>Balaenoptera physalus</i>	Endangered
Humpback whale	<i>Megaptera novaeangliae</i>	Endangered
Sei whale	<i>Balaenoptera borealis</i>	Endangered
Sperm whale	<i>Physeter macrocephalus</i>	Endangered

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).

A. Listed Resources Not Considered Further in this Opinion

Atlantic Sturgeon GOM DPS. The authorized activities would include netting and acoustic array monitoring by boat, activities which have potential to interact with Atlantic

sturgeon since Atlantic and shortnose sturgeon are known to co-occur. The PI for this shortnose sturgeon permit (16306) has applied for a 10(a)(1)(A) directed research permit for Atlantic sturgeon (permit 16526), and the Biological Opinion for permit 16526 analyzes the effects of this research on Atlantic sturgeon. Therefore, the Atlantic sturgeon GOM DPS will not be considered further in this Opinion.

Sea Turtles and Cetaceans. The authorized activities would include netting in freshwater or freshwater-tidally mixed areas and monitoring by boat of the acoustic array receivers that will be positioned as pinpointed in Figure 1. The acoustic arrays would be positioned from coastal areas to areas upriver. Netting will take place upriver. Although sea turtles and some listed whales occur in the coastal realm within the action area, we believe that it is highly unlikely that these animals would swim upriver to where nets will be set. Therefore, entanglement in nets is expected to be unlikely. Netting safeguards have been incorporated into the permit in case of the rare chance that a sea turtle or marine mammal may swim upriver. These safeguards include: 1) continual, complete, and thorough visual net checks; 2) netting time restricted between 30 minutes after sunrise to 30 minutes before sunset; and 3) no deployment of nets if other listed species are found in the action area. Sea turtles and listed whales, if at all, would most likely be found in estuarine and coastal areas within the action area. As stated previously, acoustic array monitoring will take place by boat close to coastal areas. The array monitoring would involve routine vessel maneuvers at the surface of the water and the boat would not be likely to strike any listed species. Since we believe that the proposed action poses a minimal threat to listed sea turtles and cetaceans occurring in the action area, we do not consider these species any further in this Opinion.

Atlantic salmon. PR1 would instigate the following measures for minimizing impacts on Atlantic salmon from shortnose sturgeon research in the GOM DPS geographic area. These minimization measures appear as conditions in permit 16306.

Atlantic Salmon Netting Minimization Conditions Include:

-Protective of Atlantic salmon, gill nets must not be set within 0.5 miles upstream or downstream of the confluences of the Kennebec River and Bond Brook, and 0.5 miles below Lockwood Dam; Nets must not be set within 0.5 miles upstream or downstream of the confluences of the Penobscot River and Cove Brook, Kenduskeag River, Ducktrap River, or Meadow Brook;

-Researchers must avoid fishing in documented locations of the Penobscot River and Kennebec complex where Atlantic salmon have been encountered in the past (Sand Island @ < 43.914465,-69.727821>; Pine Island @ < 43.914465,-69.727821>; and Fort Halifax Park @ < 44.54482,-69.627271>) and (in shallower, non-channel waters of Oak Point Cove @ 44.667005,-68.822994; and Graham Station @ 44.821459,-68.708721);

-Six inch gillnets may be fished in main channels of rivers and bays of the research area at depths greater than 20 feet at low tide. Nets may also be fished in areas characterized as “mudflats,” off main channels in waters less than 10 feet at low tide;

-To limit snagging nets on bottom structure, a sounding device and Global Positioning System (GPS) is optionally recommended;

-If a net becomes snagged on bottom substrate or debris, it must be untangled immediately while attempting to reduce stress on captured animals; and

-Nets may be fished at water temperatures between 0°C and 26°C and at dissolved oxygen concentrations of 4.5 mg/l (or 55% saturation) or greater during deployment. See summary of environmental conditions below.

Additionally, other conservative measures protective of salmon in the action area would be employed. These would include: (1) constantly monitoring nets; (2) removing animals from nets as soon as capture is recognized; (3) fishing no more than ten hours when water temperatures are less than 15°C; (4) using up to three hour intervals when water temperatures are between 15 and 20°C; (5) using up to two hour intervals when water temperatures are between 20 and 25°C; (6) and checking nets every hour at water temperatures between 25 and 28°C.

We concluded, based on the methods proposed by researchers in the action area, and their resulting limited interactions with Atlantic salmon over an extended period of time, adherence to the above measures would likely minimize potential future salmon interactions; and thus, no incidental capture or mortality for Atlantic salmon will be authorized. Therefore, Atlantic salmon are not considered further in this Opinion.

Critical Habitat. No critical habitat has been designated for shortnose sturgeon; therefore, none will be affected by the proposed action. However, critical habitat exists for Atlantic salmon within the action area. Coincident with a June 19, 2009 endangered ESA listing for GOM distinct population segment (DPS) Atlantic salmon, NMFS and the USFWS designated critical habitat (74 FR 29300; June 19, 2009). The new listing was expanded to include all anadromous Atlantic salmon streams whose freshwater range occurs in watersheds from the Androscoggin River northward along the Maine coast northeastward to the Dennys River, and wherever these fish occur in the estuarine and marine environment. (For a full description of the Atlantic salmon critical habitat, refer online at: http://www.nero.noaa.gov/prot_res/altsalmon/4%28b%29%282%29%20Report%20Final.pdf). Therefore, proposed research in both the Kennebec complex and Penobscot River would occur in newly delineated Atlantic salmon critical habitat. None of the planned netting and boating south of the Kennebec complex (i.e., Saco River and intervening rivers) would occur within the boundaries of the GOM DPS, and thus would also not affect critical habitat in rivers south of the Kennebec complex.

Critical habitat is defined as specific areas containing physical and biological features essential to the conservation of the species. Primary Constituent Elements (PCE's) for critical habitat identified in the GOM DPS Atlantic salmon include factors essential for the conservation of the species. Within the occupied range of the Gulf of Maine DPS, Atlantic salmon PCEs are regarded as providing: sites for spawning and incubation, sites for juvenile rearing, and sites for unobstructed migration. A detailed review of the physical and biological features required by Atlantic salmon is provided in Kircheis and Liebich (2007). The description of Atlantic salmon critical habitat is online at <http://www.nmfs.noaa.gov/pr/species/fish/atlanticsalmon.htm>.

The critical habitat PCE relevant to permit 16306 focuses on providing unobstructed migratory pathways for Atlantic salmon adults and smolts. Thus, specific PCE factors and conclusions potentially impacting critical habitat for salmon under the proposed action were found to be as follows:

(1) Freshwater and estuary migratory sites free from physical and biological barriers delaying or preventing access of adult salmon seeking spawning grounds needed to support recovered populations: This factor is related to adult Atlantic salmon returning to their natal rivers or streams requiring migration sites free from barriers obstructing or delaying passage to reach their spawning grounds at the proper time for effective spawning (Bjornn and Reiser 1991). Migration sites free from physical and biological barriers are essential to the conservation of the species because without them, adult Atlantic salmon adults would not be able to access spawning grounds needed for egg deposition and embryo development. The extent adult salmon migration would be blocked by the proposed fisheries research proposals is relevant to the impacts on critical habitat.

This analysis examined the potential for the research obstructing migratory pathways between adjacent riverine and estuarine critical habitat units. We concluded that the research nets present a very small barrier in place relative to the size of the remaining river area available for salmon migration. Nets are checked at minimum each hour when in use, or immediately, if an animal is captured, and is therefore not a permanent structure. Moreover, gillnetting employed by researchers has been conditioned in current permits to successfully limit interaction within the Atlantic salmon migratory pathways as evidenced by the small numbers of salmon netted historically. Consequently, we do not believe proposed netting in either of the project modifications would affect the ability of the critical habitat to provide unobstructed migratory pathways for adult Atlantic salmon.

(2) Freshwater and estuary migration sites free from physical and biological barriers delaying or preventing emigration of smolts to the marine environment: This feature is essential to the conservation of the species because Atlantic salmon smolts require an open migration corridor from their juvenile rearing habitat to the marine environment.

D-shaped ichthyoplankton nets (D-nets) are described as gear for collecting shortnose sturgeon eggs and larvae in potential sturgeon spawning areas in the Kennebec, Androscoggin and Penobscot River systems (Kieffer and Kynard 1996). D-nets measuring approximately 1 meter in diameter, 3 meters long, with a mesh size of 1-2 mm, could potentially serve as a physical barrier for the emigration of Atlantic salmon smolt. In the proposed research, up to three D-nets would be deployed and anchored in a row along the deepest channel bottoms near spawning sites 100 to 300 meters downstream of known or suspected sturgeon spawning areas. These nets would soak for no more than 3 hours at a time before being raised and examined for eggs or larvae before being re-deployed. However, because D-nets would be anchored to the river bottom, drifting smolt near the surface would not be exposed to likely capture. Moreover, as there have been no smolts captured in the Kennebec and Penobscot Rivers while using D-nets, we concluded that D-nets would not affect the ability of the critical habitat to provide an unobstructed downstream migratory pathway for Atlantic salmon smolts.

(3) Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation: Adult Atlantic salmon and Atlantic salmon smolts interact with other diadromous species indirectly while migrating. Adult and smolt migration through the estuary often coincides with the presence of alewives (*Alosa* spp.), American shad (*Alosa*

sapidissima), blueback herring (*Alosa aestivalis*), and striped bass (*Morone saxatilis*). The abundance of diadromous species present during adult migration may serve as an alternative prey source for seals, porpoises and otters (Saunders *et al.* 2006). For example, as Atlantic salmon smolts pass through the estuary during migration from their freshwater rearing sites to the marine environment, they experience high levels of predation. These features are essential to the conservation of the species because without highly prolific abundant alternate prey species such as alewives and shad, the less prolific Atlantic salmon would likely become a preferred prey species.

We examined whether proposed research activities would appreciably reduce the abundance of riverine or estuarine buffer prey for Atlantic salmon adults or smolts within the migratory critical habitat. We examined whether prey species structure in action area would be affected by the proposed action, but concluded, based on the limited amount of by-catch of the above species captured by researchers in the past, and the fact that virtually all of the by-catch reported has been reported released during sampling, there would be minimal impacts to associated buffer prey organisms in the freshwater and estuarine critical habitat. Thus, we concluded that the ability of the critical habitat providing fish communities as protective buffers against predation, does not obstruct migratory pathways for adult or juvenile Atlantic salmon in either action.

After analyzing the specific PCEs above that are relevant to the proposed action, we do not believe that Atlantic salmon GOM DPS critical habitat will be affected by the proposed action. Therefore, we do not consider it further in this Opinion.

B. Status of Species Considered in this Opinion

Shortnose sturgeon

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 (Skjveland *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 2. 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 <i>et al.</i> 1982
		2003	9,500	6,942 - 13,358	Squiers 2003
Androscoggin River	ME		7200	5000 - 10,800	Squiers <i>et al.</i> 1993
Merrimack River	MA	1989 – 1990	33	18 - 89	NMFS 1998
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,
Hudson River	NY	1980	30,311		Dovel 1979, NMFS 1998
		1995	38,000	26,427 - 55,072	Bain <i>et al.</i> 1995, NMFS 1998
		1997	61,000	52,898 - 72,191	Bain <i>et al.</i> 2000
Delaware River	NJ, DE, PA	1981/1984	12,796	10,288 - 16,367	Hastings <i>et al.</i> 1987
		1999/2003	12,047	10,757 - 13,589	Brundage and O'Herron 2003
Chesapeake Bay	MD, VA	no data	-	-	
Potomac River	MD, VA	no data	-	-	

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
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	-	-	
ACE Basin	SC	no data	-	-	
Savannah River	SC, GA		1,000 - 3,000		Bill Post, SCDNR 2003
Ogeechee River	GA	1990s	266		Bryce <i>et al.</i> 2002
		1993	266	236 - 300	Kirk <i>et al.</i> 2005
		1993	361	326 - 400	Rogers and Weber 1994
		1999/2000	195	-	Bryce <i>et al.</i> 2002
		2000	147	105 - 249	Kirk <i>et al.</i> 2005
		2004	174	97 - 874	Kirk <i>et al.</i> 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 <i>et al.</i> 1998
Saint Marys River	FL		unknown	-	Kahnle <i>et al.</i> 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 3). 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 3: 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, except for shortnose sturgeon populations in the Merrimack and Connecticut Rivers (Table 3).

Shortnose Sturgeon Populations in Maine

Kennebec Complex

Abundance Estimates. Maine Department of Marine Resources (MDMR) has conducted studies determining distribution and abundance of shortnose sturgeon in the estuarine complex of the Kennebec, Androscoggin and Sheepscot rivers (Squiers and Smith, 1979, Squiers *et al.* 1982). Additional studies were conducted determining the timing of spawning run and location of spawning areas in the tidal section of the Androscoggin River (Squiers *et al.* 1982; Squiers 1983; Squiers *et al.* 1993). The estimated size of the adult population (>50cm TL), based on a tagging and recapture study done from 1977 through 1981, was 7,200 with a 95% C.I. of 5,000 - 10,800 (Squiers *et al.* 1982). The average density of shortnose sturgeon in the estuarine complex of the Kennebec River was the second highest of any population studied through 1983 (Dadswell *et al.* 1984). Another population study was conducted from 1998 through 2000. The Schnabel estimate using the tagging and recapture data from 1998, 1999, and 2000 was 9,488 with a 95% confidence interval of 6,942 to 13,358 (Squiers 2003).

Spawning. Suspected spawning areas on the Androscoggin and Kennebec rivers were identified in gillnet studies conducted from 1977 through 1981 (Squiers *et al.* 1981; Squiers *et al.* 1982).

Androscoggin River

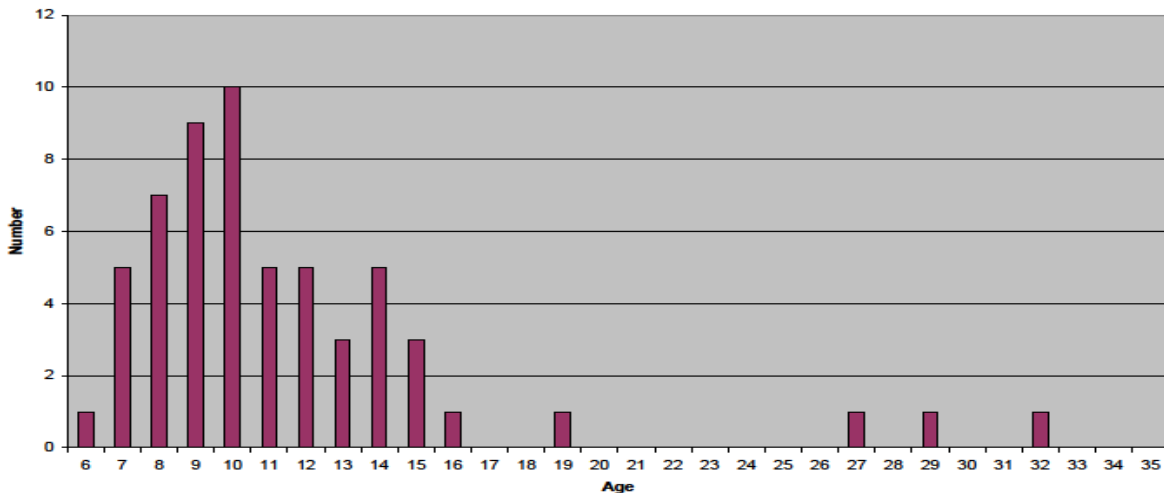
According to Squiers (1983) large catches of shortnose sturgeon were made on the Androscoggin River about 400 m downstream of the Route 201 bridge between Brunswick and Topsham from late April through mid-May. This site is approximately 44 km upriver from the mouth of the Kennebec

River in the direction of Brunswick through Merrymeeting Bay. Temperatures ranged from 8.5°C to 14.5°C during the time of these large catches. Many of the male sturgeon captured each year were freely expressing milt. During 1983, a few female sturgeon were so ripe that eggs were extruded as they were retrieved from the nets Squires (1983). The substrate at the sampling site graduated from ledge, boulders, cobbles, pebbles, and gravel on the Brunswick shore to sand in the middle to silt on the Topsham shore. The maximum depth at low tide was 6.7 m, with an average depth of 3 m. Water velocities measured along a transect from the Brunswick shore to the Topsham shore during an outgoing tide ranged from 32cm/sec. to 60cm/sec. A follow-up study (Squires *et al.* 1993) was conducted in 1993 using radio telemetry, artificial substrate, and bottom set plankton nets. Ripe shortnose sturgeon were concentrated for a distance of about 500 m below the Brunswick Hydroelectric dam approximately 100 m upriver of the Route 201 bridge (river kilometer (rkm) 44). Shortnose sturgeon eggs were collected using artificial substrate and plankton nets. The spawning migration extended from the end of April to the last week in May. Spawning occurred from at least May 7 through May 19 based on the presence of eggs on the artificial substrate. The temperature from late April through the end of May ranged from 7°C to 17°C. Gillnet catches and radio telemetry indicated that the peak spawning occurred from May 8 to May 10 at a water temperature of 14°C.

Figure 3 below illustrates mean age of 12 years (median 10 yr) determined for 58 shortnose sturgeon adults collected on the spawning run in the Androscoggin River in 1981 (Squires *et al.* 1982; labeled as Figure 2 within the publication). The Lengths ranged from 52.5 cm FL to 90.0 cm FL with the average fork length of 68.9; however, sex was undetermined.

Figure 3: Mean age of shortnose sturgeon captured in the Androscoggin River.

Figure 2: Age of shortnose sturgeon captured in the Androscoggin River, ME during the 1981 spawning run.



Kennebec River

Spawning site(s) on the Kennebec River are not as well delineated as the site(s) on the Androscoggin River (T. Squires, MDMR, pers. comm.2008). Squires *et al.* (1982) suspected a site to occur 11 km below the former Edwards Dam (rkm 59) where males extruding milt were collected

in 1980 and 1981. Additional sampling occurred on May 11, 1999 approximately 10 km below the former Edwards Dam (rkm 60) to collect tissue samples. During this sampling, 135 adults were captured in an overnight set. The water temperature was 14 °C and it is assumed that these sturgeon were on the spawning run (Squires 2003).

MDMR also conducted an ichthyoplankton survey from 1997 through 2001 to monitor the recolonization of the habitat above the Edwards Dam removed in 1999. In the results summarized by Squires (2003), 12 sampling sites were established above the former dam site and thirteen sites were established below the former dam site. Surface tows with one-meter plankton nets (800 microns) or stationary sets of one-half meter D-shaped plankton nets (1600 microns) were made at each station. Small numbers of shortnose sturgeon eggs and/or larvae were collected at sites located in the first nine kilometers below the former Edwards Dam each year (rkm 61-70). No shortnose sturgeon eggs or larvae were collected above the former Edwards Dam site in 2000 or 2001 (Squires 2003). The latest collection of ELS on the Kennebec River occurred in 2009 when 23 larvae were captured at rkm 64 with D-nets (G. Wippelhauser, Maine Dept. of Marine Fisheries, pers. comm. 2010).

While there have not been any directed studies to determine if shortnose sturgeon are utilizing potential spawning habitat above the former Edwards Dam, several shortnose sturgeon have been captured incidental to other studies in Waterville (27 kilometers above the former Edwards Dam) since its removal (G. Wippelhauser, Maine Dept. of Marine Fisheries, pers. comm. 2009).

Foraging. Tracking data and gillnet studies indicate that the majority of shortnose sturgeon feed in the Bath region of the Kennebec River (rkm 16 to rkm 29) from mid April through late November and early December, then migrate upriver to overwinter in Merrymeeting Bay (T. Squires, MDMR, pers. comm.,2008). Although the major concentration of shortnose sturgeon is found in the Bath region which includes the Sasanoa River, shortnose sturgeon are also found in Montsweag Bay in the lower Sheepscot River and in Merrymeeting Bay (rkm 29 to rkm 42) located upriver of Bath. Based on limited gillnetting data and telemetry data it appears that shortnose sturgeon occasionally make forays upriver to the Augusta/Gardiner (rkm 59-70) area during the summer months (T. Squires, MDMR, pers. comm.,2008).

The salinities in the main foraging area in the Bath Region range from 0 to 21ppt from May through November. There is very little stratification during most of this time period and the difference in salinities from the surface to the bottom are usually less than 1 ppt. The temperature ranges from 4°C in April to over 24°C in July, to around 5°C in late November. Dissolved oxygen levels are almost always near 100% saturation (T. Squires, MDMR, pers. comm. ,2008). Some shortnose sturgeon also utilize Montsweag Bay, a part of the Sheepscot River, as a foraging area. The Sheepscot is interconnected with the Kennebec River through the Sasanoa River and Hockomock Bay. Salinities ranged from 12 to 28 parts per thousand and temperatures ranged from 12 to 22°C in June and July in Montsweag Bay during an ultrasonic telemetry study (McCleave *et al.* 1977).

Stomach contents of shortnose sturgeon captured in Montsweag Bay were examined by McCleave *et al.* (1977). The most common food items were crangon shrimp (*Crangon septemspinous*); clams (*Mya arenaria*); and small winter flounder (*Pseudopleuronectes*

americanus). No food habit studies have been conducted for shortnose sturgeon in the Kennebec River (T. Squires, MDMR, pers. comm., 2008).

Tracking studies indicate shortnose sturgeon make use of two large marshes in the Bath area; Hanson Bay (Pleasant Cove; rkm 21) in the Sasanoa River and Winnegance Cove (rkm 17) in the Kennebec River. A Wetland Functional Assessment was conducted by Bath Iron Works (BIW) as part of the review of impacts of the proposed expansion of the shipyard into wetlands habitat (Normandeau 1998). The benthic community in Winnegance Creek was assessed as part of this study and the benthic assemblage in Winnegance Creek (rkm 17) contained no mollusks, a preferred food of adult shortnose sturgeon in other rivers (Dadswell, 1979, Dadswell *et al.* 1984). One of the dominant available species in Winnegance Creek, however, was the sabellid polychaete (*Maranzariella viridis*), found in stomachs of shortnose sturgeon in the Saint John River, but not preferred there.

No sampling for epibenthic invertebrates was done in the BIW Wetland Functional Assessment. On numerous occasions, however, gammarid amphipods were observed on the nets when sampling for sturgeon in the summer foraging area (T. Squires, MDMR, pers. comm., 2008). In an earlier study on the food habits of smelt in the lower reaches of the Kennebec River, the dominant food item was gammarids, particularly *Gammarus oceanicus* (Flagg 1974). Although, the stomach contents of shortnose sturgeon were not sampled in this part of the Kennebec complex, shortnose sturgeon consumed gammarid amphipods and polychaete worms in the estuary of the Connecticut River (Savoy and Benway 2004), in the Hudson River (Haley 1999), and on the Edisto and Savannah River (Collins *et al.* 2008); and it is thus likely, shortnose sturgeon in the Kennebec complex would also prefer the same food item.

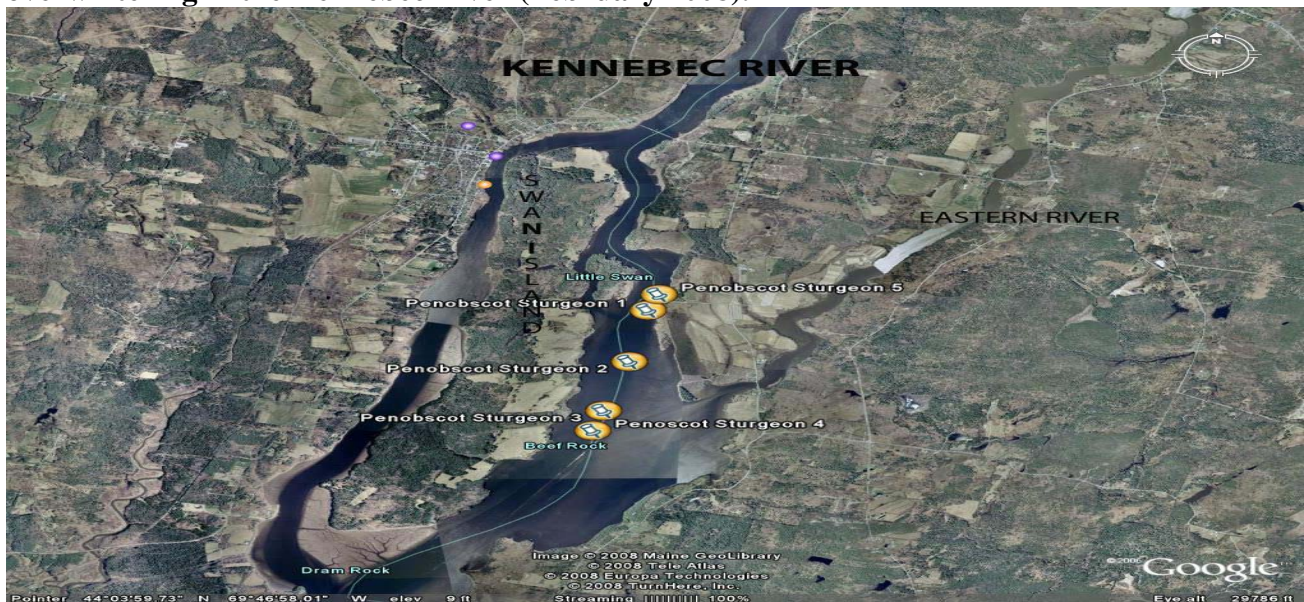
Overwintering/Resting Areas. No studies had been done to locate the overwintering sites of adult shortnose sturgeon in the Kennebec River prior to 1996. Based on catch per unit effort from gillnet sets in the lower Kennebec River, it was thought the likely overwintering sites in the estuarial complex was in the deep saline region of the lower river (below Bluff Head, rkm 15) and possibly in the adjacent estuary of the Sheepscot River (Squires *et al.* 1982). It was also known some shortnose sturgeon overwintered in the tidal freshwater sections of the Eastern and Cathance rivers; both are tributaries to Merrymeeting Bay (Squires *et al.* 1982). MDMR attempted to identify shortnose sturgeon overwintering sites in the Kennebec in 1996. A total of fifteen shortnose sturgeon were outfitted with sonic transmitters in October and November 1996 in order to track them to their overwintering habitat. Initial capture locations of the sturgeon varied within the Kennebec System. Eight individuals were captured, tagged and released in Pleasant Cove (rkm 21) on the Sasanoa River which joins the Kennebec River in Bath just a short distance downriver of the Carlton bridge; five were captured, tagged and released in Winnegance Cove (rkm 17), located approximately 2700 m below the Carlton Bridge on the Kennebec River, and two were captured in Merrymeeting Bay (rkm 38) and released at the Richmond town landing in channel west of Swan Island (rkm 40.5) (T. Squires, MDMR, Pers. Comm. 2008).

The eight shortnose sturgeon captured in Pleasant Cove and the five captured in Winnegance Cove were all relocated. Eleven of the thirteen were relocated in Merrymeeting Bay. The first two sturgeon tagged in Pleasant Cove (code #338 and 356) were never found in Merrymeeting

Bay. Sturgeon # 338 did move from Pleasant Cove to Winnegance Cove and back, and sturgeon # 356 moved to Days Ferry (rkm 24) and back. (T. Squires, MDMR, Pers. Comm. 2008). Both sturgeons were last found in Pleasant Cove (rkm 21) on November 13, 1996. After November 13, 1996 sturgeon with transmitters were only found in upper Merrymeeting Bay on the east side of Swan Island (rkm 38). Eleven individual sturgeon were identified in this area. It became impossible to separate signals as the sturgeon grouped together. Multiple signals were found at the suspected overwintering site near Swan Island in Merrymeeting Bay on every occasion it was checked. Poor ice conditions made it difficult to cover large areas in Merrymeeting Bay and its tributaries so it was possible that not all sturgeon overwintered at the suspected overwintering site but no other signals were received at other sites which included smelt camp colonies on the Kennebec, Eastern, Cathance and Abagadasset rivers (T. Squires, MDMR, Pers. Comm. 2008).

Movement and Migration. Additionally, in October and November of 2007, MDMR using its passive array of receivers, detected five pre-spawning adult shortnose sturgeon overwintering in the Kennebec River having been initially captured and ultrasonically tagged in the Bangor/Brewer overwintering area of the Penobscot River in late September 2007 (Fernandes *et al.* 2008) Four of these individuals were subsequently relocated in the Kennebec River overwintering area (Merrymeeting Bay) near rkm 38 in February 2008. These sturgeon were located between rkm 37.25 to 39.25. This stretch of river is tidally influenced freshwater and the depths are approximately 4.5 to 6.0 m with a predominant sand substrate.

Figure 4: Location of shortnose sturgeon captured from the Penobscot River overwintering in the Kennebec River (February 2008).



Saco River and Other Rivers South of the Kennebec Complex

A recent discovery of shortnose sturgeon within the Saco River has complicated the understanding of shortnose sturgeon in Maine waters. Prior to capture of two SNS from this watershed in 2009, it was previously believed this species was absent from southern Maine,

because shortnose sturgeon were not considered able to make use of the numerous smaller river systems along Maine's coast due to dams blocking access of sturgeon to freshwater areas.

Atlantic sturgeon have been documented in the Saco (Sulikowski, unpublished), and shortnose sturgeon have also been documented transiently using the Medomak, St. George, and Damariscotta Rivers (G. Zydlewski *et al.* unpublished). Further, recent ultrasonic tracking data now suggest shortnose sturgeon make use of these systems during their forays between the larger drainage systems that might support reproduction.

In early April 2010, researchers from the U.S. Geological Survey (USGS) reported a high percentage of late-stage females captured in the fall and winter of 2009 from the Merrimack River (MA), migrated to known or suspected spawning sites in the Kennebec River (a distance of 285km) (M. Kieffer, U.S. Fish and Wildlife Service, pers. comm. 2010). Of 26 late-stage shortnose sturgeon females captured in the Merrimack River near Haverill, MA, six were acoustically tagged. And of these fish, five (86%) were later detected in April 2010 in the Kennebec River. Interestingly, two of these same fish were also detected in the Saco River during their transit, signifying a much larger coastal migration of the endangered shortnose than previously understood and also indicating the importance of Maine's southern rivers in terms of stock connectivity (i.e., immigration and emigration) and demographic correspondence (i.e., similar or unique aspects of population dynamics, reproduction, life history traits and behaviors), all factors critical to status assessment and management of these species.

Penobscot River

Abundance Estimates. In May 2006, the University of Maine (UM), in conjunction with NMFS and the U.S. Geological Survey (USGS), began a study of the distribution, abundance, and movements of adult and sub-adult Atlantic sturgeon in the Penobscot River. These research efforts confirmed the presence of shortnose sturgeon in the river. In 2006, 62 shortnose sturgeon were captured by UM in the Penobscot River from Frankfort upstream to Bangor. Between May 21, 2007 and September 10, 2007, an additional 99 individual shortnose sturgeon were captured and tagged in the river. A total of 185 shortnose sturgeon were captured in the river in 2008 and 221 in 2009. All sturgeon captured during the study were adults or large juveniles, as the type of gear used for sampling (large mesh gillnets of 6" and 12" stretch) were not designed to capture sturgeon less than 2 feet in length.

Using the 2006 and 2007 mark-recapture data, UM researchers used two different calculation methods to obtain a preliminary population estimate for the Penobscot River (Fernandes *et al.* 2008). Using a Lincoln/Peterson Index, an estimate of 1,049 fish was calculated (95% confidence interval of 673 and 6,939). A Schnabel estimate was also calculated yielding an estimate of 1,710 shortnose sturgeon. It must be noted that both models assume a closed population (no mortality, birth or migration takes place). Fernandes *et al.* (2008) used capture data from 2006 and 2007 to calculate Peterson and Schnabel estimates of population size. The Peterson estimate of shortnose sturgeon abundance was 1,425 with a confidence interval of 203-2647. The Schnabel estimate was 1,531 with a confidence interval of 885-5681. As reported by Fernandes *et al.* (2008), these two methods require a large number of recaptures for a precise estimate of abundance, and were likely affected by the low number of recaptures in this study.

Additionally, several of the assumptions of these tests were violated, including the lack of a closed population and random sampling. However, researchers believe that these estimates, particularly the Lincoln/Peterson Index, are a reasonable first attempt at an estimate. Researchers are currently exploring other open and closed model assumptions related to when fish are non-transient.

Habitat. In 2009, spawning mats and ichthyoplankton nets were used to detect potential spawning below Veazie Dam (Zydlewski 2009a). While no actual spawning activity was detected, suitable spawning areas were described, using data on bathymetry, water temperature and velocity (Zydlewski 2009a). Sturgeon movement into and out of the Penobscot River estuary also was documented, including immigration into the Kennebec River estuary (Fernandes *et al.* 2008).

Telemetry studies indicate while shortnose sturgeon are present in the river and estuary throughout the year, their movements vary by season in response to water temperature and flow. From mid-October to mid-April most tagged shortnose sturgeon concentrate in a relatively small section of river near Bangor. Following overwintering they move downstream into the estuary until returning upstream in summer during low flows. Tagged fish were observed upstream 2 km below the Veazie Dam by August. At the end of summer, shortnose sturgeon moved downstream to the location of the overwintering site in the Bangor area (Fernandes *et al.* 2008, Zydlewski 2009b). The preliminary telemetry data collected by UM suggests that sub-adult and adult shortnose sturgeon move extensively within the river system during spring and early summer and often can be found over mudflats outside the main river channel (Fernandes *et al.* 2006). Spawning areas have not yet been identified. However, researchers suspect, based on the literature, spawning would likely take place as far upriver as sturgeon can migrate, allowing larvae and juveniles the most freshwater habitat downriver before entering estuarine conditions. This location would be consistent with just downstream of the Veazie Dam, at water temperatures and depths between 8 and 18°C and 1-5m, respectively, at water velocity between 50-125 cm/s, and on cobble/rubble substrate 101-300 mm diameter available at the site.

Outside of spawning, shortnose sturgeon typically occur over soft substrates consisting of mud, silt or sand, and commonly in deeper channels or over tidal mud flats (NMFS 1998). Such habitat is extensive in the Penobscot River from the estuary upstream to the area around Bangor and Brewer (Fernandes *et al.* 2008, Zydlewski 2009a, Zydlewski 2009b). Much of this soft sediment consists of bark, sawdust or wood chips, which were deposited as a result of log-driving and operation of saw mills and pulp and paper operations on the river. These soft sediment areas were found to be used by shortnose sturgeon throughout the year in recent University of Maine studies (Fernandes *et al.* 2008).

Movement and Migration. Many tagging and telemetry studies in rivers throughout the species' range indicate shortnose sturgeon remain in their natal river or the river's estuary (Dadswell *et al.* 1984, NMFS 1998). However, recent data collected by UM and MDMR indicate migration between river systems is more extensive than was previously thought. Sonic transmitters were implanted in a total of thirty-nine shortnose sturgeon from June 14, 2006 through September 27, 2007 in the Penobscot River by University of Maine; (S. Fernandes, University of Maine, pers. comm. 2008). Eleven of these sturgeon have been subsequently

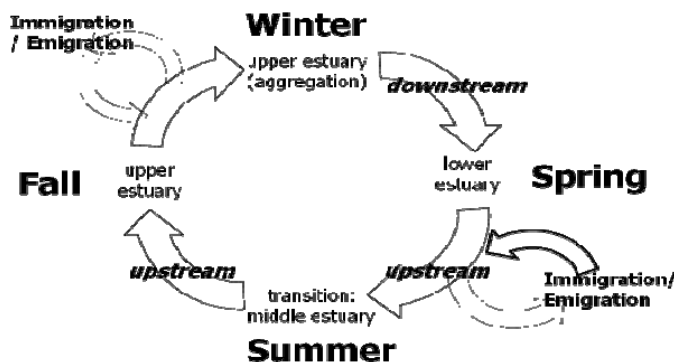
detected in the Kennebec River by MDMR with its passive array of receivers. It is approximately 70 km between the mouth of the Kennebec River and the mouth of the Penobscot River; however, one tracked individual traveled 230 km from its tagging site in Bangor on the Penobscot River to upper Kennebec River (S. Fernandes, University of Maine, pers. comm. 2007). Additionally, movement from the Kennebec to the Penobscot was documented when two shortnose sturgeon PIT tagged by MDMR in the Kennebec River in 1998 and 1999 were recaptured in the Penobscot River in 2006 by University of Maine researchers

Five pre-spawning shortnose sturgeon sonic tagged in late September 2007 in the Bangor overwintering area on the Penobscot River (S. Fernandes, University of Maine, pers. comm. 2007, T. Squires, pers. comm. 2008) were detected by the MDMR with its passive array of receivers in the Kennebec River in October and November 2007. Four of these five sturgeon were subsequently relocated in the Kennebec River overwintering area near rkm 38 in February 2008. In addition, the fifth shortnose sturgeon implanted with a transmitter during the same time period and area and was subsequently relocated in the Kennebec River overwintering area.

In the following year (2008) MDMR deployed its passive array of receivers to document movement of the five overwintering sturgeon in the Kennebec, and four of the five on the overwintering grounds in February 2008 were tracked. These four were females with late stage eggs. One migrated upriver to the Farmingdale/Hallowell (rkm 61) reach in the Kennebec River which had been previously identified by MDMR as a spawning area. Another migrated to Waterville (rkm 97), the upstream limit of sturgeon habitat made accessible with the removal of the Edwards Dam in 1999. A third migrated to the known spawning area on the Androscoggin River near Brunswick, ME (rkm 44). These three moved rapidly downriver after a few days and are presumed to have left the Kennebec River system. The fourth sturgeon with late stage eggs migrated to the mouth of the Androscoggin and was last relocated in Merrymeeting Bay on May 12, 2008. Its signal was not picked up on any of the downriver receivers.

Based on a model developed by the University of Maine for coastal immigration and emigration of Penobscot River sturgeon (See Figure 5 below), the stock structure is thought to be relatively stable with minimal immigration and emigration occurring in the winter and summer months. Conversely, migration into and out of the system is believed to occur in two distinct periods of time—after spawning and prior to overwintering. Movements of sturgeon captured during the congregated periods would enable researchers to later assess seasonal movements and migrations of sturgeon stocks between rivers using telemetry and mark and recapture open models.

Figure 5: Seasonal movement patterns of SNS in the Penobscot River (adapted from Fernandes *et al.* 2008).



(Beginning in winter, adult SNS aggregate from November to April in a distinct section of river; when water temperatures and discharge rise in the spring they move to the lower estuary. Later in the spring/early summer some of these individuals leave the river (emigration) and others return (immigration). Those staying in the river system move upstream to the middle estuary in mid-summer and again further upstream in the fall. In late fall/early winter another set of individuals immigrates and emigrates from the river before the wintering aggregation forms in November).

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 in the action area 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 by the ESA. However, shortnose sturgeon are taken incidentally in other anadromous fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979, Dovel *et al.* 1992, Collins *et al.* 1996). In the northeast, approximately 20 sturgeon are killed annually by commercial and recreational fishing (NMFS 1998). In most cases fish are returned to the river, presumably unharmed. Moser and Ross (1993) found that captures of shortnose sturgeon in commercial shad nets disrupted spawning migrations in the Cape Fear River, and Weber (1996) reported that these incidental captures caused abandonment of spawning migrations in the Ogeechee River, Georgia. The Penobscot River is an important migratory corridor for alewife (*Alosa pseudoharengus*), American eel (*Anguilla rostrata*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), striped bass (*Morone saxatilis*), and lobster (*Homarus americanus*). The incidental take of shortnose sturgeon in the Penobscot River is unknown due to confusion between Atlantic and shortnose sturgeon and a reluctance to report illegal bycatch to authorities. Poaching is likely another fishing threat, but its impacts to individual population segments is unknown. Poaching may be more prevalent where legal markets for sturgeon exist from importations, commercial harvest, or commercial culture.

Dams. 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.

On the Kennebec River, construction of Edwards Dam at Augusta, Maine (rkm 71) in 1837 denied sturgeon access to historical habitat in the Kennebec River, until 1999 when it was removed. Since its removal, almost 100% of historic habitat has been opened and shortnose sturgeon. Recently sturgeon have been documented using much of the opened habitat, spawning at the Lockwood Dam (rkm 98) indicating the available habitat is being utilized to a certain level.

On the Penobscot River, there are currently two obstructions to spawning habitat. In 1833, the Veazie Dam was constructed at rkm 56, and blocked 29 km of habitat that was historically accessible to sturgeon. Just upstream of the Veazie Dam is the Great Works Dam (rkm 41.3; completed in 1887). Five kilometers downstream of the Veazie Dam was the Treats Falls Bangor Dam (completed in 1875) which also impeded migration during the summer months. The Treats Falls Bangor Dam, however, was breached in 1977 and now allows diadromous fish passage. Thus, there are currently 50 km of tidal and freshwater habitat currently available for sturgeon spawning and nursery habitat. Moreover, current plans for the removal of the Veazie and Great Works Dams will restore access to approximately 22 km more shortnose sturgeon habitat.

The restoration of access by dam removal in both the Kennebec and Penobscot Rivers is likely to coincide with that of the historic range. Any increase in carrying capacity and an increase in abundance and distribution of shortnose sturgeon would result from increased availability of spawning, low salinity, and foraging and overwintering habitat, each factor improving the viability of early life stages and juveniles.

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

third 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 4 below). The report analyzes water quality, sediment, coastal habitat, benthos, and fish contaminant indices to determine status on a range from good to fair to poor. The results are notably poorer in the north than in the south. The northeast region of the U.S. (Virginia to Maine) was rated fair-poor. The Gulf of Mexico region (Texas to Florida) was rated fair-poor. The southeast region of the U.S. (Florida to North Carolina) was rated good-fair, the best rating in the nation.

Table 4. 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; and Gulf of Mexico=TX to FL)

Status Index	Region		
	Northeast	Gulf of Mexico	Southeast
Water quality	Fair	Fair	Fair
Sediment	Fair-poor	Poor	Fair
Coastal Habitat	Good-fair	Poor	Fair
Benthos	Poor	Poor	Good
Fish Tissue	Poor	Good	Good-fair
Overall	Fair-poor	Fair-poor	Good-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. Shortnose sturgeon collected from the Delaware and Kennebec Rivers had total toxicity equivalent concentrations of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), PCBs, DDE, aluminum, cadmium, and copper above adverse effect concentration levels reported in the literature (ERC 2002, 2003).

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 *et 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, pentachlorophenol (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).

Contaminants in Maine. Contaminant reports for rivers in Maine are produced by Maine's Surface Water Ambient Toxics (SWAT) monitoring program (MDEP 2009). Field studies conducted by the State of Maine Department of Environmental Protection (DEP) indicate that there is significant contamination by dioxin, PCBs, chlorophenols and heavy metals of the rivers and the estuaries in the state of Maine. Samples of fish from the Androscoggin, Kennebec, Penobscot, Salmon Falls, St. Croix, and Sebasticook rivers generally exceeded the Maine Center for Disease Control's (MCDC) fish tissue action levels (FTAL) for PCBs, used for setting fish consumption advisories, at most of the 39 stations sampled throughout the State of Maine. There are fish consumption advisories for several Aroostook County (northernmost county in Maine adjacent to Penobscot County) rivers and streams issued by the MCDC because of residuals of DDT used decades ago. Samples of trout from eight of ten Aroostook County rivers and streams sampled in 2009 significantly exceeded MCDC's FTAL used for setting the advisories. In addition, pulp mills are a major industry (7 total) in the state, all of which formerly used a bleached kraft method. Two of the seven mills are located on the Penobscot River within the action area. Mills release significant levels of halogenated aromatic hydrocarbons (HAH) into the water as a byproduct of the chlorine bleaching process which include dioxins. Significant levels of dioxin have been detected in finfish, shellfish, and crustaceans in waters below the two Penobscot mills.

Land Use Practices. According to the U.S. Department of Agriculture (Plantinga *et al.* 1999), about 90 percent of the land in Maine is forest land. The remaining 10 percent of the land area is divided among agricultural uses (3 percent), urban uses (2 percent), and other uses (5 percent). Future projections estimate that urban uses and non federal public timberland will grow with agricultural uses declining.

Power Plants. 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.

There was one nuclear power plant in Maine - Maine Yankee. This reactor was permanently shut down in 1997. There are various utility companies that currently have operational power plants (not nuclear) of various types (hydro, steam, coal, etc.) in the action area. These companies are Arcadia Energy, Aroostook and Bangor Resources, Bangor Hydro-Electric Co., Boralex Livermore Falls, Inc., Casco Bay Energy Co. LLC, ESOCO Orrington, Inc., and FPL Energy Maine Hydro LLC.

Research. Shortnose sturgeon have been the focus of field studies since the 1970s. The primary purposes of most studies are 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, examples of which include, capture, handling, biopsy sampling, lavage, laparoscopy, attachment of scientific instruments, and release. Research on shortnose sturgeon in the U.S. is carefully controlled and managed so that 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.

There are currently 10 scientific research permits targeting shortnose sturgeon having similar objectives (capture, handle, tag & release) as the proposed studies in Maine (Table 5). There is potential for overlap in time and space in the different permitted research. However, it is a standard condition of NMFS permits for research on sturgeon that researchers coordinate their activities with those of other permit holders to avoid unnecessary disturbance of animals.

Table 5. Existing shortnose sturgeon research permits similar to the proposed action.

<i>Permit No.</i>	<i>Location</i>	<i>Authorized Take</i>	<i>Research Activity</i>
<u>10115</u> Expires: 8/3/2013	Satilla & Saint Marys Rivers, GA & FL	85 adult/juv 20 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, collect ELS
<u>14394</u> 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
<u>10037</u> 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
<u>14759</u> Expires: 8/19/2015	North Carolina Rivers	70 adult/juv.	Capture, handle, weigh measure, Floy tag, PIT tag, genetic tissue sample; anesthetize acoustic tag
<u>14176</u> Expires: 9/30/2015	Potomac River	30 adult/juv. 20 ELS	Capture, handle, weigh, measure, Floy PIT tag, genetic tissue sample; anesthetize w/ electronarcosis; & internal acoustic tag
<u>14604</u> Expires: 4/19/2015	Delaware River and Estuary NJ & DE	1,000 adult/juv. (1 lethal), 300 ELS	Capture, handle, measure, weigh, Floy tag, PIT tag, tissue sample, anesthetize, ultrasonic tag, laparoscopy, blood collection, collect ELS
<u>14396</u> Expires: 12/31/2014	Delaware River and Estuary NJ & DE	100 adult/juv	Capture, handle, measure, weigh, Floy tag, PIT tag, genetic tissue sample, anesthetize, and sonic tag
<u>1580</u> 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
<u>15614</u> Expires: 5/23/2016	Lower Conn. River & Estuary., CT	500 adult/juv (2 lethal); 300 ELS	Capture, handle, measure, weigh, PIT & Floy tag acoustic tag, gastric lavage, fin ray section, collect ELS
<u>1595-04</u> Expires: 3/31/2012	Penobscot River and Estuary, ME	300 adult/juv. (2 lethal); 50 ELS	Capture, handle, measure, weigh, boroscope, tissue sample, blood sample, PIT & Floy tag, anesthetize, acoustic tag, collect ELS, lavage, scute sample

Permitted researchers are also required to notify the appropriate NMFS Regional Office at least two weeks in advance of any planned field work so that the Regional Office can facilitate this coordination and take other steps appropriate to minimize disturbance from multiple permits. A Biological Opinion was issued for each of the permits authorized for shortnose sturgeon, including the requirement for consideration of cumulative effects to the species (as defined for the ESA). For each permit, a Biological Opinion concluded that issuance was not likely to jeopardize the continued existence of the shortnose sturgeon, either individually or cumulatively.

Conservation. 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 Maine is responsible for developing TMDLs for the action area.

The Maine Department of Environmental Protection manages programs such as those for air, waste, soil, water, fish, and wildlife that impact the action area. The Air Quality section conducts licensing, monitoring, and assessment throughout the State of Maine. The Land and Water Quality section conducts the following activities: 1) grants and loans; 2) monitoring and assessment involving biological monitoring, classification of Maine waters, dioxin monitoring, impaired waters and general water quality reports, invasive aquatic plants, lakes, river modeling and data reports, stream studies, surface water ambient toxics monitoring (SWAT), water use, and wetland monitoring; 3) permits and standards; and resources including coastal waters, groundwater, lakes, streams, wetlands; and 4) watershed planning and management. The remediation and waste management section manages aboveground tanks, asbestos, biomedical, brownfields, drinking water protection, emergency spill response, federal facilities and superfund program, groundwater fund, hazardous waste, landfill remediation and closure program, lead hazard prevention, non hazardous waste transporter program, oil conveyance, petroleum clean up, residuals, sludge and composting, solid waste, spill prevention countermeasure controls, transporters, underground tanks, and waste oil.

Integration of the Environmental Baseline. The above activities within the action area pose threats to its shortnose sturgeon populations in the following ways. Many activities cause *death* – definite removal of individual fish from the Maine river populations – at the adult, juvenile, and larval stages. Other activities cause *injury* to the fish, 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 fish are bycatch in commercial and recreational fishing, cooling water intakes and power plants, bridge construction, 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. During dredging activities, hydraulic dredges can kill

sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to kill shortnose sturgeon. Finally, 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 fish. Commercial and recreational fishing industries that catch shortnose sturgeon 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 these fish.

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

Along with fluctuations in the DO and salinity concentrations, other waterborne contaminants may affect the aquatic environment, causing injury to shortnose sturgeon. These contaminants may come from land use practices, or point and non-point source pollution. Issues such as raised fecal coliform and estradiol concentrations affect all of the wildlife using the river as a habitat. The impact of many of these waterborne contaminants on shortnose sturgeon is unknown, but they are known to affect other species of fish in rivers and streams. These compounds may enter the aquatic environment via wastewater treatment plants, agricultural facilities, as well as runoff from farms (Folmar *et al.* 1996, Culp *et al.* 2000, Wildhaber *et al.* 2000, Wallin *et al.* 2002). For instance, estrogenic compounds are known to affect the male-female sex ratio in streams and rivers via decreased gonadal development, physical feminization, and sex reversal (Folmar *et al.* 1996). Although the effects of these contaminants are unknown in shortnose sturgeon, Omoto *et al.* (2002) found that by varying the oral doses of estradiol-17 β or 17 α -methyltestosterone given to captive hybrid (*Huso huso* female \times *Acipenser ruthenus* male) “bestor” sturgeon they could induce abnormal ovarian development or a lack of masculinization. These compounds, along with high or low DO 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 10 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. Excluding the permit authorization being considered

here, there are no other shortnose sturgeon directed research permits in the action area at this time.

Activities potentially altering the habitat of shortnose sturgeon are dredging and land use activities. Due to their benthic nature, dredging for shipping and other activities destroys shortnose feeding areas, disrupts spawning migrations, and fills spawning habitat with resuspended fine sediments. Land use activities also have the capacity to fill spawning habitat with sediments if those activities release sand and silt into the action area.

MDMR has conducted studies determining distribution and abundance of shortnose sturgeon in the estuarine complex of the Kennebec, Androscoggin and Sheepscot rivers (Squiers and Smith, 1979, Squiers *et al.* 1982). Additional studies were conducted determining the timing of spawning run and location of spawning areas in the tidal section of the Androscoggin River (Squiers *et al.* 1982; Squiers 1983; Squiers *et al.* 1993). The estimated size of the adult population (>50cm TL), based on a tagging and recapture study done from 1977 through 1981, was 7,200 with a 95% C.I. of 5,000 - 10,800 (Squiers *et al.* 1982). The average density of shortnose sturgeon in the estuarine complex of the Kennebec River was the second highest of any population studied through 1983 (Dadswell *et al.* 1984). Another population study was conducted from 1998 through 2000. The Schnabel estimate using the tagging and recapture data from 1998, 1999, and 2000 was 9,488 with a 95% confidence interval of 6,942 to 13,358 (Squiers 2003).

In May 2006, the University of Maine (UM), in conjunction with NMFS and the U.S. Geological Survey (USGS), began a study of the distribution, abundance, and movements of adult and sub-adult Atlantic sturgeon in the Penobscot River. These research efforts confirmed the presence of shortnose sturgeon in the river. In 2006, 62 shortnose sturgeon were captured by UM in the Penobscot River from Frankfort upstream to Bangor. Between May 21, 2007 and September 10, 2007, an additional 99 individual shortnose sturgeon were captured and tagged in the river. A total of 185 shortnose sturgeon were captured in the river in 2008 and 221 in 2009. All sturgeon captured during the study were adults or large juveniles, as the type of gear used for sampling (large mesh gillnets of 6" and 12" stretch) were not designed to capture sturgeon less than 2 feet in length.

Using the 2006 and 2007 mark-recapture data, UM researchers used two different calculation methods to obtain a preliminary population estimate for the Penobscot River (Fernandes *et al.* 2008). Using a Lincoln/Peterson Index, an estimate of 1,049 fish was calculated (95% confidence interval of 673 and 6,939). A Schnabel estimate was also calculated yielding an estimate of 1,710 shortnose sturgeon. It must be noted that both models assume a closed population (no mortality, birth or migration takes place). Fernandes *et al.* (2008) used capture data from 2006 and 2007 to calculate Peterson and Schnabel estimates of population size. The Peterson estimate of shortnose sturgeon abundance was 1,425 with a confidence interval of 203-2647. The Schnabel estimate was 1,531 with a confidence interval of 885-5681. As reported by Fernandes *et al.* (2008), these two methods require a large number of recaptures for a precise estimate of abundance, and were likely affected by the low number of recaptures in this study. Additionally, several of the assumptions of these tests were violated, including the lack of a closed population and random sampling. However, researchers believe that these estimates,

particularly the Lincoln/Peterson Index, are a reasonable first attempt at an estimate. Researchers are currently exploring other open and closed model assumptions related to when fish are non-transient.

A recent discovery of shortnose sturgeon within the Saco River has complicated the understanding of shortnose sturgeon in Maine waters. Prior to capture of two SNS from this watershed in 2009, it was previously believed this species was absent from southern Maine, because shortnose sturgeon were not considered able to make use of the numerous smaller river systems along Maine's coast due to dams blocking access of sturgeon to freshwater areas. Atlantic sturgeon have been documented in the Saco (Sulikowski, unpublished), and shortnose sturgeon have also been documented transiently using the Medomak, St. George, and Damariscotta Rivers (G. Zydlewski *et al.* unpublished). Further, recent ultrasonic tracking data now suggest shortnose sturgeon make use of these systems during their forays between the larger drainage systems that might support reproduction.

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 amendment of critical habitat. The proposed activities authorized by permit 16306 would expose shortnose sturgeon to capture, handling, genetic tissue sampling, PIT and Floy tags, internal or external acoustic tags, anesthetization (MS-222 or electronarcosis), gastric lavage, sex identification/boroscope, apical spine sampling, blood sampling, fin ray sectioning, and ELS collection. 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, 2) handling, 3) genetic tissue sampling, 4) PIT and Floy tags, 5) internal or external acoustic tags, 6) anesthetization (MS-222 or electronarcosis), 7) gastric lavage, 8) sex identification/boroscope, 9) apical spine sampling, 10) blood sampling, 11) fin ray sectioning, and 12) ELS collection. All captured shortnose sturgeon would be measured, weighed, PIT tagged, Floy/T-bar tagged, tissue sampled, boroscoped, photographed, and released. Depending on the research objective to be met, several subsets of captured shortnose sturgeon would further be assigned additional take activities. One subset of the sturgeon would additionally be fitted with an internal or external satellite tag; another subset

would have an apical spine (or scute) removed; a third subset would be blood sampled; a fourth subset would undergo gastric lavage; and a fifth subset would have a fin ray section removed. As required for the specific procedure, fish would be anesthetized using tricaine methanesulfonate (MS-222) or electronarcosis. Finally, up to 50 ELS per year would be collected in the Penobscot and Kennebec Rivers, 10 ELS per year would occur in the Saco River, and 100 ELS per year would be collected in the Merrimack River. Activities are expected to occur in the action area 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 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 1 identifies the numbers of shortnose sturgeon that are expected to be exposed annually under the proposed permit 16306. All captured shortnose sturgeon would be measured, weighed, PIT tagged, Floy/T-bar tagged, tissue sampled, boroscoped, photographed, and released. Depending on the research objective to be met, several subsets of captured shortnose sturgeon would be assigned additional take activities. One subset of the sturgeon would additionally be fitted with an internal or external satellite tag; another subset would have an apical spine (or scute) removed; a third subset would be blood sampled; a fourth subset would undergo gastric lavage; and a fifth subset would have a fin ray section removed. As required for the specific procedure, fish would be anesthetized using tricaine methanesulfonate (MS-222) or electronarcosis. Finally, up to 50 ELS per year would be collected in the Penobscot and Kennebec Rivers, 10 ELS per year would occur in the Saco River, and 100 ELS per year would be collected in the Merrimack River.

The time required to complete routine, non-invasive methods (*i.e.*, PIT and Floy 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/MS-222 anesthetizing, telemetry tagging, boroscope, scute sampling, and genetic tissue sampling would vary, but would typically average less than 15 minutes per fish. Implantation of internal transmitters and external transmitter 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. Shortnose sturgeon would be captured using a combination of trammel and gillnets. Permit 16306 would authorize the capture of the following amounts of shortnose sturgeon from the action area: 200 from the Penobscot River, 400 from the Kennebec River, 80 from the Saco River, 200 from small coastal rivers in Maine and New Hampshire, and 185 from the Merrimack River for research procedures. Entanglement in nets 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 DO waters, 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 is summarized in Table 6 below. Mortality rates due to the netting activities ranged from 0 to 1.22%. Of the total 5,911 shortnose sturgeon captured by gillnets 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 D.O. concentrations. Moser and Ross (1995) reported gillnet mortalities approached 25% when water temperatures exceeded 28°C even though soak times were often less than 4 hours.

Table 6: Number and percentage of shortnose sturgeon killed by gillnets or trammel nets associated with existing scientific research permits.*

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

*Note that this table does not yet incorporate a recent June 3, 2010 Delaware River shortnose sturgeon mortality.

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 the June 3, 2010 Delaware River mortality mentioned above. 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), gillnetting for shortnose sturgeon could be done with lowered risk of direct mortality.

Expected Response to Capture. As demonstrated above, there is a chance that shortnose sturgeon could die in gillnets, 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 conditions related to capture. 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. 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.

Therefore, the capture methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. 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. All shortnose sturgeon would be handled for length and weight measurements and the other proposed methods under this proposed research authorization. Permit 16306 would authorize the handling of the following amounts of shortnose sturgeon from the action area: 200 from the Penobscot River, 400 from the Kennebec River, 80 from the Saco River, 200 from small coastal rivers in Maine and New Hampshire, and 185 from the Merrimack River for research procedures. 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. Sturgeon are a hardy species, but can be lethally stressed during handling when water temperatures are high or DO is low (Kahn and Mohead 2010). Sturgeon may inflate their swim bladder when held out of water (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.

Sturgeon are sensitive to handling stress when water temperatures are high or D.O. is low. 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. Additionally, sturgeon tend to inflate their

swim bladder when stressed or when handled in air (Moser *et al.* 2000). If not returned to neutral buoyancy prior to release, sturgeon tend to float and would 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 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. Mitigation measures described in the environmental assessment, such as wearing rubber gloves to reduce skin abrasions, short handling times, recovering in floating pens, total holding time of less than 2 hours, and an electrolyte bath prior to release, should lessen the chance of injury or mortality during handling and restraint in any of the river systems. 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 populations in the action area. 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, Bratney 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 11.9 mm x 2.1 mm on fish \geq 300 mm TL 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 populations in the action area. By extension, PIT tagging is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the appropriate sizes of PIT tags are used and tagging protocols are closely followed.

Floy (T-bar Anchor) Tags. All shortnose sturgeon captured would also be marked with Floy tags. This tagging method could help make collection of information useful for the assessment of the sturgeon population in the action area. In all captured sturgeon, Floy tags would be anchored in the dorsal fin musculature base and inserted forwardly and slightly downward from the left side to the right through dorsal pterygiophores. After removing the

injecting needle, the tag would be spun between the fingers and gently tugged to be certain it is locked in place. During the study, the rate of Floy tag retention would be documented and reported in NMFS annual reports.

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

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

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

To lessen known negative impacts described above using the Floy tag, sterile tagging technique would be used and methods would require to subsequently monitor dorsal fin tag sites of recaptured sturgeon for any lesions. Additionally, results of tag retention and fish health would be reported to NMFS in annual reports and as requested by NMFS. If impacts of the Floy tags are other than insignificant, NMFS would reevaluate their use in the permit.

Therefore, the Floy tagging methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, Floy tagging is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the Floy tag protocols are closely followed.

Tissue Sampling. All shortnose sturgeon captured would be tissue-sampled (2.0 cm²). The sample would be collected from the trailing margin of soft tissue of one of the pectoral fins using sharp sterilized scissors. Tissue sampling does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact.

Expected Response to Tissue Sampling. 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). Therefore, the tissue sampling methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, tissue sampling is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as proposed methods are closely followed.

Endoscopy/Boroscope. For permit 16306, borescopic examination would be authorized for all adult shortnose sturgeon captured (>69 cm TL) excluding those releasing gametes at time of capture. Borescopic examination is used in fish species to qualitatively assess morphological health and to visually identify the sex and maturity status of study fish accurately. An endoscope is inserted through the urogenital pore, which avoids having to make an incision as is done with a laparoscopic procedure (Kynard and Kieffer 2002; Ortenburger *et al.* 1996). Endoscopes may be flexible or rigid. The rigid endoscope always requires a straight path to the organs being examined whereas the flexible endoscope may give and bend (Dover and Van Bonn 2001).

When compared to other methods, endoscopic examination has been shown as an accurate method for determining the sex of fish from the Acipenseridae and Salmonidae families. Swenson *et al.* (2007) utilized laparoscopy to correctly determine the maturity status and sex of mature individuals for 96% of the eastern brook trout examined in their study. The percentage was determined by euthanizing trout after laparoscopy for dissection and comparing results of the two methods. Wildhaber *et al.* (2005) assessed the effectiveness of ultrasound versus laparoscopy for sex determination of shovelnose sturgeon by verifying results with histological analysis. These researchers found that the success of the method used for sex determination was dependent upon its invasiveness, whereby laparoscopy was more effective than ultrasound.

Within endoscopic technique, borescopic examination through the urogenital pore is not as consistent as sex determination of laparoscopy through incision (shovelnose sturgeon; Wilhaber *et al.* 2005). Introduction of the endoscope through the urogenital pore was not difficult in female arctic char, but resulted in accidental rupture of the spermatic duct in some of the males (Ortenburger *et al.* 1996). Furthermore, Kynard and Kieffer (various sturgeon species; 2002) observed an unpredictability of urogenital opening size based on length of fish. They recommended choosing an endoscope with small rather than large diameter. To avoid this

unpredictability, it could be prudent to utilize an incision, rather than urogenital pore insertion, to create a predictable opening and therefore the endoscope diameter could properly be chosen.

Many studies comment on the absence of injury or other evident damage from endoscopic procedure and report it to be a relatively safe procedure when carried out carefully. It is reported that laparoscopy does not harm reproductive structures, does not cause internal damage such as bruising or infection, and does not cause hemorrhage or buoyancy problems. Kynard and Kieffer (2002) reported that careful use of an endoscope will not harm reproductive structures and is suitable for all sturgeon species. They also report that endoscopes inserted through the urogenital pore will not damage the female oviduct valve. Moccia *et al.* (1984) noted that necropsy of rainbow trout maintained under controlled lab conditions revealed no evidence of internal damage from a previous endoscopic procedure, such as internal bruising or infection. They also note that gross healing of the surgical incision is 70% complete in 7 – 10 days, without signs of inflammation or other damage even without antibiotics. Hernandez-Divers *et al.* (2004) reported that no morbidity or mortality occurred as a result of laparoscopy to Gulf of Mexico sturgeon as there was no significant hemorrhage or trauma associated with any fish. Furthermore, they also noted that no postoperative swimming or buoyancy problems (i.e. swim bladder injury) were observed in their study.

Laparoscopy post-procedure mortality is reported in the literature for Salmonidae, and has been attributed to small fish size and coincident chronic gill disease infection. Swenson *et al.* (2007) reported a 3.3% post-procedure mortality for laparoscopy of eastern brook trout, which was limited to trout smaller than 70 mm FL. These fish were from the smallest class size Swenson *et al.* (2007) examined for their study and therefore they hypothesized that smaller individuals may be at greater risk from laparoscopy than larger fish. They suggested this could be due to the fact that the procedure may have taken longer for small fish because it was more difficult to view internal organs. Ortenburger *et al.* (1996) reported that 2 of the arctic char that underwent laparoscopy in their study died compared to none in the control group. This was attributed to severe chronic gill disease and no signs of peritonitis or inflammation of the coelomic viscera were found on necropsy and subsequent histological examination of deceased fish (Ortenburger *et al.* 1996). These researchers were ultimately unable to definitively relate deaths to the procedure described – because both deceased fish had survived for more than 5 days following procedure and were diagnosed as having severe degenerative gill disease at the time of death (Ortenburger *et al.* 1996).

It has also been suggested that stresses incurred during the procedure and delayed complications, as well as increased susceptibility to predation after release, could also contribute to mortality. Moccia *et al.* (1984) suggested that incidental loss of epidermal mucus, increases in body temperature, drying of the skin, or a combination of these factors could contribute to eventual mortality in fish that undergo laparoscopy, but their previous laboratory studies indicate this is unlikely. Although immediate mortality may be low post-laparoscopy, we should not rule out the possibility of delayed complications from laparoscopy, such as reopening of the incision, infection, and injury to internal organs (Swenson *et al.* 2007). Accidental perforation of the caudal air bladder was known to have occurred in 3 of the 70 arctic char evaluated by Ortenburger *et al.* (1996). Ecchymotic hemorrhages were seen on microscopic evaluation of the tissue surrounding the genital pore only in female arctic char that had ovulated and hemorrhage

appeared to be associated with oviposition rather than introduction of the endoscope (Ortenburger *et al.* 1996). Inflammatory infiltrates were only seen surrounding the genital pore in male arctic char, and may indicate disruption of the normal communication of the vas deferens (Ortenburger *et al.* 1996). The blind and forced puncture of an endoscopic cannula and trocar into the coelom can potentially cause visceral bruising or perforation and researchers used a threaded design for gradual advancement by rotation to avoid bruising (Hernandez-Divers *et al.* 2004). The use of insufflation pressure greater than 4-8 mm Hg could compromise circulation, especially venous return, in fish with lower arterial and venous blood pressures (Hernandez-Divers *et al.* 2004). Fish released into wild settings after laparoscopy may be more susceptible to these and other sources of related mortality, such as subsequent predation (Swenson *et al.* 2007).

Further study is needed to evaluate the long-term lethal and sublethal effects of endoscopy in natural settings and there is still a need to document the continued fertility of fish subjected to endoscopy. However, studies of radio tagging, a procedure that is more invasive than endoscopy, suggest that these problems are minimal. For example, radio tags in largemouth bass and dummy acoustic transmitters in juvenile Atlantic salmon had few long-term effects on fish in the wild (Cooke *et al.* 2003; Lacroix *et al.* 2004).

Expected Response due to Endoscope/Boroscope. We expect that the shortnose sturgeon exposed to procedures under this action would respond similarly as revealed in the literature above. Since the proposed methodologies would be using the endoscopic technique through the urogenital pore (boroscope) and not by incision (laparoscope), we expect to see less complications than from open wound surgery. Therefore, we do not expect to see significant hemorrhage or trauma associated with the procedure. We also do not expect postoperative swimming problems. Finally, the post-procedure mortality seen in Salmonidae has been attributed to small fish size and gill infection. Borescopic examination would only be conducted on adult fish > 69 cm TL. Available information reports that endoscopy is safe when carried out carefully. To that end, all of the project staff responsible for performing the borescopic examination under this action have received training. Due to the above factors, borescopic examination methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, it is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as proposed methods are closely followed.

Electronarcosis. Electronarcosis (or MS-222, *see* next section) would be authorized for anesthetizing shortnose sturgeon for surgery while implanting or attaching acoustic or satellite tags (up to 105 annually), fin ray sectioning (up to 115 annually), or while performing gastric lavage (up to 125 annually) from the action area. Electrical current can cause electrotaxis (forced swimming), electrotetanus (muscle contractions), and electronarcosis (muscle relaxation) in fish (Summerfelt and Smith 1990). Due to the varying results that can occur from electrical current, it is important to realize that an ideal anesthetic should induce anesthesia rapidly with minimum hyperactivity or stress (Coyle *et al.* 2004). The electronarcosis state is achieved through the use of electrical current for anesthesia, as electrotaxis and electrotetanus do not result in minimum hyperactivity or stress. Henyey *et al.* (2002) state that electronarcosis is ideal for non-invasive research, but that more research is needed to determine exactly how electronarcosis works. Hartley (1967) states that using straight DC (as opposed to pulsed DC) provides no

anesthetic effect, but rather acts to block cerebral messages to the longitudinal efferent nerves to prevent the sensation of pain. Coyle *et al.* (2004) also notes that electronarcosis immobilizes fish but isn't a true anesthetic. The methods in Henyey *et al.* (2002) elicited narcosis, not tetany; Kynard (U.S. Geological Survey, *pers comm.*, December 2008) states that the fish's nerve pathway is blocked at the medulla oblongata.

Recovery time from electronarcosis is shorter than with chemical anesthetics, as fish can swim upright as soon as the electricity is turned off (Summerfelt and Smith 1990). As soon as the sturgeon is placed in, or is removed from the electrical current, several researchers have reported immediate narcosis or recovery (Gunstrom and Bethers 1985; Summerfelt and Smith 1990; Henyey *et al.* 2002). 95% of white sturgeons exposed to electronarcosis recovered immediately in a study by Holliman and Reynolds (2002).

When compared to chemical anesthetics, such as MS-222, electronarcosis shows significant benefits, such as this short recovery time. Evaluations comparing anesthesia induced using MS-222 and electrical narcosis have yielded similar results of muscle relaxation and immobility (Kynard and Lonsdale 1975; Henyey *et al.* 2002); however, a marked increase in induction and recovery time was experienced when using MS-222 compared to electronarcosis. Juvenile lake and shortnose sturgeons immobilized with 80 mg/L of tricaine took a significantly longer time to orient than control fish or fish immobilized with electricity for 5 or 30 minutes (Henyey *et al.* 2002). Induction and recovery from electronarcosis both take less than one minute while induction and recovery takes place in 3-5 minutes and 5 to 7 minutes respectively with MS-222.

Factors such as size and water temperature can influence electronarcosis. Larger fish are more rapidly electronarcotized than smaller ones, with larger sturgeon becoming immobilized at lower voltages than smaller sturgeon (Coyle *et al.* 2004, Henyey *et al.* 2002). Electronarcosis has been shown to be most effective when water temperatures are between 10 and 25°C (Henyey *et al.* 2002).

Physiological effects or effects on reproduction have been little-studied on sturgeon, however a few studies reveal these effects of electronarcosis on other fish. For northern pike, survival of eggs from fertilization to eye-up did not significantly differ between eggs collected from electronarcotized adults and adults anesthetized with MS-222 (Walker *et al.* 1994). Juvenile bull trout exposed to continuous- or pulsed-DC electroshock exhibited rapid elevations in plasma cortisol and glucose, but plasma chloride did not change (Barton and Dwyer 1997).

Previous studies employing electronarcosis on sturgeon have yielded good results. Since Henyey *et al.* (2002) published their methods, researchers on the Potomac River and Chesapeake Bay began using similar electronarcosis techniques (since 2004) anesthetizing shortnose and Atlantic sturgeon. Internal transmitter tags were surgically implanted under electronarcosis with no adverse affects reported (Mike Mangold, USFWS, *pers comm.*, January 2009). In another study in South America, researchers followed similar methods and reported similar results (Alves *et al.* 2007). Henyey *et al.* (2002) also used this method in the lab and monitored shortnose sturgeon for 6 weeks following electronarcosis measuring no adverse effects in that time. No change in swimming or feeding behavior, and no burns or bruising of the skin or mortalities were seen (Henyey *et al.* 2002). Furthermore, Kynard (application for Permit 1549)

reported several years of data showing no mortality following anesthetization with electronarcosis.

Expected Response to Electronarcosis. We expect that shortnose sturgeon undergoing electronarcosis would respond similarly to the research revealed above. The risk associated with electronarcosis is over-applying the direct current causing cessation of opercula movement and involuntary respiration. However, NMFS believes that with proper training this method is safe for inducing narcosis and, if used carefully on green, shortnose, and Atlantic sturgeon, there is very little chance of mortality or harmful injury. Therefore, the electronarcosis methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, electronarcosis is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as proposed methods are closely followed.

MS-222. MS-222 (or electronarcosis, *see* previous section) would be authorized for anesthetizing shortnose sturgeon for surgery while implanting or attaching acoustic or satellite tags (up to 105 annually), fin ray sectioning (up to 115 annually), or while performing gastric lavage (up to 125 annually) from the action area. Following the methods of Summerfelt and Smith (1990) the dosage of MS-222 will vary according to water temperature and dissolved oxygen levels. The minimum circulating dose of MS-222 will be used, starting on the low end of the concentration range and increasing the dose slightly if the fish does not respond as desired within a couple of minutes.

MS-222's mode of action prevents the generation and conduction of nerve impulses directly affecting the central nervous system, cardiovascular system, neuromuscular junctions, and ganglion synapses (Brown 1988). It is rapidly absorbed through the gills. However, 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 MS-222. Due to the fact that the applicant aims to use a concentration within the recommended limitations of MS-222 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). 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 and monitoring recovery in boat-side net pens before releasing fish.

Therefore, the anesthesia methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, 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.

External Acoustic or Satellite Tags. The implantation of external tags would be authorized on up to 105 shortnose sturgeon in the action area. Applicants would use sonic transmitter devices limited in size to no more than 2% of a given fish's body weight. These same fish will have also been tagged with PIT and Floy tags and will have undergone all other procedures included in the study except internal transmitter implantation.

External transmitters could be shed. Collins *et al.* (2002) showed hatchery shortnose sturgeon were able to shed 100% of their external transmitters (9 cm long, 1.7 cm diameter) when attached with a wire through the dorsal fin. However, the same researcher reported no external transmitter tags lost when attached to a dart tag using heat shrunk plastic wrap. Counihan and Frost (1999) found no external tags were shed by juvenile white sturgeon after one to three weeks. Sutton and Benson (2003) reported a 14.4% shedding rate for external tags (2.1 – 4.0 cm), with 27% of the larger tags (3.4 - 4.0 cm) shed.

Higher retention rates of external tags could occur with the use of newer, smaller external tags and successful methods of attachment. Newer, smaller external tags range in size between 18 and 46 mm long and only 7 to 9 mm in diameter. Using 70 to 100 lb test monofilament line, Randall and Sulak (pers. comm. to Jason Kahn, NMFS, 2009) described a method for attaching such tags bound externally to the dorsal fin using lightweight heat shrink electrical splice tubing and five minute, two-part epoxy. These researchers documented over 96% retention rates on Gulf sturgeon during 2005 to 2008 using the following method.

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).

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.* 1997). 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).

Expected Response to External Acoustic Tags. We expect that shortnose sturgeon exposed to external sonic transmitters would respond similar to the available information presented above. It is possible that external tags could be shed. We do not expect mortality to occur as a result of this procedure. We expect that growth rates or swimming performance could be affected. We expect that the needle wounds from threading through the dorsal fin would heal normally, but acknowledge that adverse effects of these proposed tagging procedures could include pain, handling discomfort, affected swimming ability, and/or abandonment of spawning runs.

The standardized protocols endorsed by NMFS (Kahn and Mohead 2010) would be used, which aim to minimize the effects caused by transmitter tags. To ensure the sturgeon can endure the weight of these tags the total weight of all transmitters and tags would not exceed 2% of the fish's body weight. Tags would only be applied when fish are in excellent condition, and would not be attempted on pre-spawning fish, nor in water temperatures greater than 27°C. By using proper precautions and 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. Therefore, the external acoustic tagging methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, external acoustic tagging is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as proposed methods are closely followed.

Internal Acoustic Tags. Up to 105 additional shortnose sturgeon annually in the action area could be collected for surgical implantation of sonic transmitters using the protocol measures presented in Kahn and Mohead (2000). Applicants would use sonic transmitter devices limited in size to no more than 2% of a given fish's body weight. These same fish will have also been tagged with PIT and Floy tags and will have undergone all of the procedures mentioned above. Although more invasive surgical procedures are required for this internal implantation, these tags provide greater retention rates than external attachment (Collins *et al.* 2002; Counihan and Frost 1999).

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 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 radio-tagged between November 14, 2004 and January 14, 2005 in the Delaware 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.* 1997). 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 effect 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 is frequently described in the relevant scientific literature. 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, therefore, expulsion could be 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 for an implant to 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 Lacroix *et al.*'s study occurred but was not a cause of death (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 Acoustic 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 is unknown. We expect that growth rates or swimming performance could be affected and that expulsion of the transmitter could occur. There have been no mortalities or infections reported to be associated with expulsion. We expect that the surgical wound would heal normally, but acknowledge that adverse effects of these proposed tagging procedures could include pain, handling discomfort, hemorrhage at the site of incision, risk of infection from surgery, affected swimming ability, and/or abandonment of spawning runs. The research methodologies will minimize these risks, as choice of surgical procedure, fish size, morphology, behavior and environmental conditions can affect the success of telemetry transmitter implantation in fish (Jepsen *et al.* 2002).

PR1 proposes to authorize the use of 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. Surgical implantation of internal tags would only be attempted when fish are in excellent condition, and would not be attempted on pre-spawning fish in spring or fish on the spawning ground, nor in water temperatures greater than 27°C or less than 0°C. By using proper anesthesia, sterilized conditions, precautions, 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.

Collection of ELS. Permit 16306 would authorize the collection of up to 210 shortnose sturgeon ELS in the action area per year. Each adult female shortnose sturgeon produces between 94,000 and 200,000 eggs every 3 years (COSEWIC 2005). The survival from egg to juvenile is likely the most critical aspect in determining the strength of the year class (COSEWIC 2005). Therefore, it is important to be conservative when analyzing the impacts of removing eggs and larvae from the river systems. For that reason, if only 1 female sturgeon reproduces each year in the river and produces a minimal number of eggs (94,000), this project would

collect approximately 0.22% of the eggs produced in that year from the action area. As such, the annual proposed take of 210/94,000 eggs or larvae could have minimal effects on the shortnose sturgeon populations in the action area.

Past tracking research has documented likely spawning migrations of gravid female sturgeon to potential spawning sites. If the presence of spawning activity can be confirmed, the location of spawning areas and the timing of the spawn would be important for future recovery planning and protection. The use of D-nets for egg and larvae collection would likely result in more timely and conclusive data pertaining to sturgeon spawning in Maine.

Expected Response due to Collection of ELS. We do not expect the collection of up to 210 shortnose sturgeon ELS annually in the action area to impact the ability of shortnose sturgeon to survive. Even if a gravid female were to produce eggs on the low end of the scale (94,000 to 200,000 eggs), 210 eggs would be a minimal 0.22% of her total production. Therefore, the ELS collection methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, the collection of 210/94,000 ELS per year in the action area is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as proposed methods are closely followed.

Scute Sample/Apical Spine Sample. PR1 would authorize the collection and preservation (for elemental analysis) the apical hooks of up to 80 scutes annually for permit 16306. Sampling would involve using an orthopedic bone cutter or small saw to collect 4-10 mm clips of the apical hooks. The scute samples would then be preserved by drying in envelopes.

Scute sampling is one of several ways to age sturgeon. Several studies have compared aging precision of calcified structures in sturgeon and have found scutes to be less precise than other structures. Hilton and Bemis (1999) studied potential problem areas in determining the homologies of skeletal elements in shortnose sturgeon. They found scute formation to be variable, with some individuals possessing poorly developed or incomplete scutes, however, individuals exhibiting extreme scute morphology variation was small relative to the number showing other forms of skeletal variation. Jackson *et al.* (2006) tested age precision of sphenoids, fin rays, dorsal scutes, and opercula in shovelnose sturgeon, and found fin rays to have the highest within and between reader precision while scutes had the lowest. Fin rays also had the lowest mean coefficient of variation. Even though scute samples are not seen as the best way to age sturgeon, the method is still used and results in appropriate age analysis with relatively good intrareader precision (Brennan and Cailliet 1989).

Expected Response due to Scute Sample. Scutes are thought to play an important role as an antipredation device, especially in small sturgeon. Therefore, these protective structures are important as protection for the life stages of the fish. However, the removal of such a small portion of scute should have minimal effect on scutes' collective viability as an antipredation device.

Scutes are removed in the same way as are fin rays, which have proven to be non deleterious (Collins *et al.* 1996). Researchers would only remove the apical hooks and this has minimal chance of resulting in adverse effects. Due to the above factors, scute sample methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, the scute sampling methodology is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as proposed methods are closely followed.

Gastric Lavage. Permit 16306 would authorize 125 samples (*i.e.* 125 shortnose sturgeon) of stomach contents via gastric lavage in the action area. 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 will be used that is recommended for sturgeons of the size 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 2006b), 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 (laved 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 (2007) conducted a pulsed gastric lavage study on shovelnose sturgeon (*Scaphirhynchus platyrhynchus*) and found no significant difference between their control group and the lavaged group. Wanner (2006a) 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 due 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). 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 received training in gastric lavage techniques and have practiced and performed lavage on surrogate species. 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 (2006a) (pallid sturgeon) showing results that indicate lavage did not negatively influence sturgeon growth.

Therefore, the gastric lavage methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in the action area. By extension, lavage performed under these permit amendments is not likely to reduce the viability of shortnose sturgeon as listed under the ESA.

Blood Sampling. Blood would be collected from the caudal veins of up to 35 shortnose sturgeon adults annually in the action area. This would be achieved by inserting a hypodermic needle perpendicular to the ventral midline at a point immediately caudal to the anal fin. The needle would be slowly advanced while applying gentle negative pressure with the syringe until blood freely flows into the syringe. Once a blood sample is collected, direct pressure would be applied to the site of to ensure clotting and prevent further blood loss (Stoskopf 1993).

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

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

shortnose sturgeon or producing sub-lethal effects as long as the procedure is conducted by a qualified veterinarian or experienced biologist.

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

Fin Ray Sample. Up to 115 shortnose sturgeon annually would be collected in the action area for age and population analyses via fin ray sample. A small section (~1 cm² 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 populations in the action area. By extension, fin ray sampling 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 2008-2012 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 Maine, Massachusetts, and New Hampshire address 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 16306 would authorize directed take of shortnose sturgeon in Maine, Massachusetts, and New Hampshire (small coastal rivers in Maine and New Hampshire, Kennebec River, Saco River, Merrimack River, and Penobscot River). The proposed activities under this permit include: 1) capture, 2) handling, 3) genetic tissue sampling, 4) PIT and Floy tags, 5) internal or external acoustic tags, 6) anesthetization (MS-222 or electronarcosis), 7) gastric lavage, 8) sex identification/boroscope, 9) apical spine sampling, 10) blood sampling, 11) fin ray sectioning, and 12) ELS collection. 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. Other threats to the survival and recovery of shortnose sturgeon include habitat fragmentation and loss, siltation, water pollution, decreased water quality (low DO, salinity alterations), bridge construction, dredging and blasting, incidental capture in coastal fisheries, impingement on intake screens of power plant operations, and land use practices. Reasonably likely future actions described in the *Cumulative effects* section include state legislation to address 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.

For the Kennebec complex, the latest recognized population estimate (Squiers 2003), using tagging and recapture data from 1998, 1999, and 2000, is 9,488 (95% confidence interval of 6,942 to 13,358). Incorporating data from the 2006 and 2007 field seasons, a Lincoln/Peterson Index calculated the preliminary population estimate for the lower Penobscot River as 1,049 individuals (95% CI: 673 – 6,939). However, a high rate of exchange of tagged fish (10 detected in 2007, representing 40% of active acoustically tagged individuals at the time) was observed (Fernandes *et al.* 2008) between the Penobscot River system and the Kennebec complex (9488 with a 95% CI of 6942 to 13358) indicating the researchers were potentially sampling a larger population beyond that confined to the Penobscot River. The only estimation for the Merrimack River, which was conducted in 1989-1990, is 33 fish with a confidence interval of 18-89 (NMFS 1998). There is no current estimate for the Saco River or small New Hampshire coastal rivers.

Permit 16306 would be valid until its expiration and would authorize non-lethal sampling methods on up to 200 from the Penobscot River, 400 from the Kennebec River, 80 from the Saco River, 200 from small coastal rivers in Maine and New Hampshire, and 185 from the Merrimack River for research procedures. All captured shortnose sturgeon would be captured, handled, weighed, measured, photographed, PIT tagged, Floy tagged, genetic tissue sampled, and sexually identified by boroscope. Smaller subsets of these fish would undergo anesthesia by either electronarcosis or MS-222 for internal or external tags, scute sampling, gastric lavage, and/or fin ray section. Blood sampling could occur on a subset of all fish captured. Additionally, 210 ELS would be captured per year from the action area.

Although some degree of stress or pain is likely for individual fish captured and exposed to research activities, 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 populations' reproduction, distribution, or numbers. Because the proposed action is not likely to reduce fitness in individual fish, or reduce the 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 permit 16306 to the Maine Division of Marine Fisheries (Gail Wippelhauser, PI) 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, 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 16306 to the Maine Division of Marine Fisheries 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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