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

Biological Opinion

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

Activity Considered: Biological Opinion on the Permits, Conservation and Education Division's proposal to issue a Permit (Number 15677) to Bill Post, South Carolina Department of Natural Resources, for research on shortnose sturgeon in South Carolina 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: MAY 26 2011 J. H. Lecky

Date: _____

Section 7(a)(2) of the Endangered Species Act of 1973 as amended (ESA) (16 U.S.C. 1531 *et seq.*) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" a listed species or critical habitat that has been designated for them, that agency is required to consult with either NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the listed resources that may be affected. For the action described in this document, the action agency is NMFS' Office of Protected Resources – Permits, Conservation and Education Division. The consulting agency is NMFS' Office of Protected Resources – Endangered Species Division.

This document represents NMFS' biological opinion (Opinion) on the effects of the proposed studies on endangered and threatened species and designated critical habitat, and has been prepared in accordance with section 7 of the ESA. This Opinion is based on our review of the Permits, Conservation and Education Division's draft Environmental Assessment, draft of Permit Number 15677, the most current shortnose sturgeon reports, recovery plan, scientific and technical reports from government agencies and the peer-reviewed literature, biological opinions on similar research, and other sources of information.

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

CONSULTATION HISTORY

This consultation examines the NMFS' Office of Protected Resources – Permits, Conservation and Education Division's (PR1) authorization of proposed permit 15677 to conduct scientific research activities on shortnose sturgeon in South Carolina rivers (Savannah River, Ashepoo, Combabee and Edisto Rivers (including the Ashepoo-Combabee-Edisto (ACE) Basin), Cooper River, Santee River, Lake Marion and its tributaries, and the Winyah Bay system, including the Black, Waccamaw, Sampit, Little Pee Dee and Great Pee Dee Rivers). The proposed permit (15677) would replace an existing permit (NMFS Permit 1505 amended as 1505-01) expiring May 15, 2011.

The original permit (1505) was issued in May 2006 to the following Principal Investigator (PI), Mr. Douglas W. Cooke, South Carolina Department of Natural Resources. The corresponding Biological Opinion concluded that issuance of Permit 1505 was not likely to jeopardize the continued existence of shortnose sturgeon.

On January 8, 2008, a minor modification was issued by PR1 (Permit Modification No.1505-01) replacing the existing Responsible Party/Principal Investigator as well as adding other Co-investigators. Also, during consultation for that amendment, new more conservative conditions following NMFS research protocols (Moser *et al*. 2000) were introduced by NMFS PR1 lessening minor impacts on shortnose sturgeon. These revised conditions addressed the manner of taking proposed in the original permit, but did not alter the focus or action area, the timing, numbers, or methods of taking.

On February 28, 2011, PR1 submitted an initiation package for Permit 15677 (that would replace 1505-01 upon its expiration) to NMFS' Office of Protected Resources – Endangered Species Division (PR3) and PR3 initiated consultation.

BIOLOGICAL OPINION

I. DESCRIPTION OF THE PROPOSED ACTION

The proposed action addressed in this Opinion is PR1's authorization of permit 15677 to Bill Post, South Carolina Department of Natural Resources. The authority for PR1's permit issuance is section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq*.). The proposed activities involve purposeful harassment, harm, wounding, trapping, capture, or collection ("take[1]") of endangered shortnose sturgeon (*Acipenser brevirostrum*) for scientific purposes.

The purpose of the activities proposed under permit 15677 is to gather information to help inform conservation management decisions to recover shortnose sturgeon in South Carolina

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

rivers. The permit would be valid for five years from the date of issuance and would authorize monitoring of the status of shortnose sturgeon in South Carolina rivers. The permit would authorize non-lethal sampling with anchored gillnets, trammel nets and trawls, capturing up to 154 shortnose sturgeon adults and sub-adults annually from the Savannah, ACE Basin, Cooper, Santee Rivers, Winyah Bay System, and Lake Marion and its tributaries. Sturgeon taken in good condition would be measured, weighed, sampled for genetic tissue analysis, and PIT and dart tagged. Additionally, up to 110 sturgeon would be anesthetized and implanted with internal sonic transmitters annually. Sturgeon sex and general health would be determined from a sample of 24 fish annually from the Cooper River using laparoscopy, and if necessary to confirm sex, biopsies of gonad material would be taken. Afterward, blood samples would be collected and processed determining endocrine disrupters. Manual tracking and passive detections of telemetered fish at fixed receiver stations would provide information about movements and habitat use. Recaptures of tagged fish would also be used to estimate abundance when appropriate. Additionally, lethal collection of up to 50 eggs and larvae from both the Savannah River and Lake Marion and its tributaries would take place during seasonal spawning activity using artificial substrates. Finally, up to 20 young of year (YOY) and other juveniles less than 300 mm would be sampled with epibenthic trawls in Lake Marion and its tributaries, and in the Savannah, ACE Basin, Cooper, Santee, and Winyah Bay System. No annual unintended sturgeon mortality or serious harm resulting from research would be authorized. The proposed take by river and activity is summarized and broken down in Table 1 as follows.

Table 1: Activities proposed to be authorized by NMFS PR1 for endangered shortnose sturgeon (*Acipenser brevirostrum*) research in South Carolina rivers under Permit No. 15677.

Takes	Species	Life Stage	Take Activity	Location	Dates
20	shortnose sturgeon (*Acipenser brevirostrum*)	sub-adult, adult	Capture with gill & trammel nets, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, sonic tag, recover, release	Savannah River	January - December
20	shortnose sturgeon (*Acipenser brevirostrum*)	sub-adult, adult	Capture with gill & trammel nets, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, sonic tag, recover, release	Edisto River	January - December
24	shortnose sturgeon (*Acipenser brevirostrum*)	sub-adult, adult	Capture with gill & trammel nets, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, laparoscopy, gonadal biopsy, blood sample, recover, release	Cooper River	January - December

Takes	Species	Life Stage	Take Activity	Location	Dates
10	shortnose sturgeon (*Acipenser brevirostrum*)	sub-adult, adult	Capture with gill & trammel nets, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, sonic tag, recover, release	Cooper River	January - December
20	shortnose sturgeon (*Acipenser brevirostrum*)	sub-adult, adult	Capture with gill & trammel nets, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, sonic tag, recover, release	Lake Marion & tributaries	January - December
20	shortnose sturgeon (*Acipenser brevirostrum*)	sub-adult, adult	Capture with gill & trammel nets, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, sonic tag, recover, release	Santee River	January - December
20	shortnose sturgeon (*Acipenser brevirostrum*)	sub-adult, adult	Capture with gill & trammel nets, measure, weigh, photograph/video, dart tag, PIT tag, genetic tissue sample, anesthetize, sonic tag, recover, release	Winyah Bay System	January - December
20	shortnose sturgeon (*Acipenser brevirostrum*)	young of year & year-class 1	Capture with trawl, measure, weigh, photograph/ video, genetic tissue sample, recover, release	Lake Marion & tributaries, Edisto, Cooper Savannah, Santee, and Winyah Bay System	January - December
50	shortnose sturgeon (*Acipenser brevirostrum*)	eggs, larvae	lethal take with buffer pads	Savannah River	January - December
50	shortnose sturgeon (*Acipenser brevirostrum*)	eggs, larvae	lethal take with buffer pads	Lake Marion and tributaries	January - December

The purpose of research would be to determine the presence, status, health, abundance, distribution and movements of shortnose sturgeon in South Carolina waters (Savannah, ACE Basin, Cooper, and Santee Rivers and Lake Marion and its tributaries, and Winyah Bay System). Recovery goals outlined within the Shortnose Sturgeon Recovery Plan (NMFS 1998) to survey for shortnose sturgeon in rivers where they have historically occurred; and to conduct mark-

recapture, telemetry, survey sampling, documenting seasonal distribution and mapping concentration areas to characterize essential habitat of shortnose sturgeon have been attempted but not yet completed in South Carolina. Prior river specific surveys have only provided snapshots of shortnose sturgeon behavior in South Carolina. By increasing the coverage area, migration patterns and inter-basin transfer can be delineated. Field work activities would include deployment and maintenance of data-logging hydrophones; gillnetting (anchored and drift) trammel netting, and trawling to capture shortnose and Atlantic sturgeon; tagging including PIT tagging, dart tagging and surgical implanting VEMCO acoustic tags under anesthesia; tissue sampling (blood, genetic, and gonad biopsy), laparoscopy (associated with sex determination and health examination) and egg collection during spawning season.

The goals of the telemetry study would involve gaining a better understanding of riverine and near coastal movements of shortnose sturgeon on a South Carolina "big picture" basis. Presently, shortnose sturgeon movements are monitored largely by river-specific studies. This study aims to augment coverage areas identifying life history data gaps by deploying a series of acoustic hydrophone receivers in major river systems surveyed. Approximately 60 receivers per river system would be placed between the mouth (near coastal) river kilometer (RKM) 0 and potential sites where spawning occurs or to the first major dam. For smaller river systems, remaining receivers will be positioned in the neighboring sounds, Intracoastal Waterway (ICW), or used in larger river systems where shortages occur. Plans also include annually telemetry tagging with acoustic transmitters up to 110 adult/sub-adult shortnose sturgeon in all of the sampling areas (Savannah, ACE Basin, including the Ashepoo, Cooper, and Santee rivers and the Lake Marion and its tributaries and the Winyah Bay System). Receivers would be downloaded and data would be shared between states and also stored in a central data base.

Sampling along coastal rivers would focus on capturing adults and juveniles during summer when sturgeon would most likely be congregated in deepwater areas (holes) located near the fresh-saltwater interface (approximately 20 to 30 kilometers from mouths of rivers). However, other sampling would be conducted at likely staging areas between late winter and early spring before the beginning of spring spawning runs. Trawling for juveniles and YOY would take place in habitat suitable for juvenile nursery. If viable populations of shortnose sturgeon could be identified in any of the South Carolina rivers, telemetry tagging of sub-adults or adults would enable monitoring temporal and spatial movement patterns helping identify critical habitat for any discovered populations. Abundance estimates would also be conducted if sufficient numbers of captured sturgeon in rivers warranted such estimates.

Additional research components would include surveys directed for developing two hydro relicensing fishway prescriptions requiring a research period prior to the consideration of any fish passage facilities on the Lake Murray Dam (SCANA Services) and on the Lake Wateree Dam (Duke Energy Company).

A smaller component of the research would also include the development, validation and implementation of an alternative genetic-based aging technique evaluating telomere genetic material collected in the study and already archived at the NOAA-NOS Archive in Charleston, SC. Currently, the only accepted aging technique for shortnose sturgeon involves removing portions of the pectoral fin spines. However, through techniques developed for other animals

using telomere length, development of standard age curves for shortnose sturgeon using telomere length would be attempted. Known-age samples would be used to test the reliability of the curve in age prediction.

Capture (Adults or Juveniles)

All necessary precautions would be taken to ensure shortnose sturgeon are not harmed during capture and handling. Adult/juvenile fish would be captured using a standardized netting protocol (anchored and drift gill or trammel nets) approximately 1-3 days per week throughout the duration of the study. No surgical procedures would take place below 7°C or above 27°C. That is, if exceeding these limits, once measured, weighed, photographed, PIT and dart tagged, and genetic tissue sampled, sturgeon would be recovered and released as soon as possible. In addition, YOY would be targeted using a "balloon" trawl net to assess recruitment.

Anchored Gill and Trammel Netting: Gill nets of 12.7 cm (5-inch) or trammel nets with inner mesh of 8.89 cm (3.5-inch) stretched mesh and outer mesh of 38.1 cm (15 inch) would be used to sample adult shortnose sturgeon. Nets would typically measure 92 m long by 1.8 m deep, although shorter nets may sometimes be used depending on areas used. Netting activity would cease in waters below 0 ºC and above 28ºC, and gill nets would be required to be constantly monitored with one exception: overnight sets for up to 14 hours would be allowed used unattended in the Edisto River above river mile 40. At all other locations, when temperatures are between 0 and 15ºC, nets must be attended during daylight hours only for up to 10 hours. In water with temperatures between 15ºC and 20°C, net sets would not exceed 4 hours; at temperatures between 20ºC and 25ºC soak times would not exceed 2 hours; and at temperatures between 25ºC and 28ºC net sets would not exceed 1 hour. Additionally, all netting would occur in waters having minimum dissolved oxygen (D.O.) concentrations of 4.0 mg/L during deployment. (See Table 2 below)

Table 2: Summary of general netting conditions (all net sets must be attended in daylight hours except where noted below)

Water Temperature (ºC)	Minimum D.O. Level (mg/L)	Maximum Net Set Duration (hr)
0 ≤ 15	4.0	14[1]
0 ≤ 15	4.0	10
15 ≤ 20	4.0	4
20 ≤ 25	4.0	2
25 ≤ 28	4.0	1
>28	N.A.	Cease Netting

1. Unattended overnight net set durations of up to 14 hours are allowed on the Edisto River (RM≥40) between November and March and also when water temperatures are between 0 and 15ºC.

Drift Gill Netting: Gill nets would be used via drifting on the rising tide or in slack tide until just after high tide for durations of approximately thirty minutes to approximately two hours, depending on the location and swiftness of the tide. Water quality conditions for drift nets would be the same as for anchored gillnets; however, all drift net sets would be continuously tended because of the risk of gear entanglement or loss of gear resulting in ghost nets. Fishing gear would be pulled immediately if it were obvious a sturgeon has been captured.

Drift gillnets would be set and marked with GPS coordinates during early stage flood tide (slack) perpendicular to the tidal current and tended closely by researchers until high tide. To maximize chances of catching sturgeon, 92-meter nets would be configured to make contact with the bottom and would have smaller mesh on the bottom two meters (McCord *et al.* 2007). Flat bottom locations free of snags near the freshwater-brackish water interface would be preferred for each drift set.

Trawling: Because smaller juvenile and YOY sturgeon age groups are not easily targeted with gill nets and other gear used for sturgeon research, a modified balloon trawl referred to as a Missouri Trawl (Herzog *et al.* 2005) would be used to annually capture up to 20 YOY in South Carolina Rivers. Fish smaller than 300 mm would not be tagged, but would be measured, weighed, and photographed before returned to the water unharmed. The Missouri Trawl proposed is a two-seam (i.e., standard) slingshot balloon trawl (Gutreuter *et al.* 1995) and is completely covered with 0.375-in heavy, delta-style mesh. The width of the trawl narrows from 16 feet at the headrope to 3feet at the mid-section to 1.25 feet at the cod (distal) end. The footrope of the trawl is 18 feet long, and a 0.375inches diameter chain attached to it which helps the footrope maintain contact with the substrate during conditions of heavy current, fast tow speeds, or undulating bottom surfaces (e.g., sand waves). A standard haul would be approximately 300 to 500 feet lasting approximately 10 to 15 minutes (Gutreuter *et al.* 1995). Trawling speed would vary between 3 to 5 miles per hour and the location of trawling would be monitored with a Garmin/Global Positioning System preventing trawling over the same bottom area in a 24-hour period.

Egg/Larvae Collection with Egg Mats: The collection and preservation of up to 50 sturgeon eggs annually from both the Savannah River and Lake Marion (and its tributaries) during the spring spawning runs of sturgeon would occur, with the objective of confirming the timing and scope of spawning activity. To locate shortnose sturgeon spawning sites 22 inch circular buffer pads would deployed in locations near spawning grounds to passively collect eggs drifting in the water. The pads would be secured with concrete weights, marked with a float and retrieved and checked for eggs every 48 to 72 hours. Eggs collected at each site would be preserved in a buffered formalin solution for later identification and verification of the spawning time.

Handling

To minimize stress during capture and handling, all shortnose sturgeon would removed from capture gear and recovered within 200 cm long x 150 cm wide x 200 cm deep boat-side net pens until. Sturgeon would be further processed onboard where they would be transferred by hand to onboard live wells containing slime coat restorative. If increased catches occur, additional net pens would be employed to accommodate excess holding of sturgeon and bycatch. During

processing, each fish would be immersed in a continuous stream of water supplied by a pump/hose assembly mounted to over the side of the research vessel and treated with a slime coat restorative. Dissolved oxygen would be supplemented with compressed oxygen to ensure D.O. concentrations do not fall below saturation. While onboard, sturgeon species would be first confirmed by a qualified biologist as they are measured, weighed, photographed. Fish identified as not previously captured, would receive a unique identifying PIT and dart tag and genetically tissue sampled. The time taken for these procedures would be approximately 2 to 3 minutes. Following this processing, fish will be returned to the net pens to ensure full recovery prior to release, except those adults (see below) selected to receive telemetry tagging, blood sampling or laparoscopy. Prior to being released, any fish not responding readily would be recovered further in the net pen by holding the fish upright and immersed in river water and gently moving the fish front to back to aid freshwater passage over the gills to stimulate the fish. When showing signs of being able to swim away strongly, the fish would be released with a spotter watching to make sure the fish stays down and is fully recovered. The total holding time of fish processed in the above manner would be variable depending on water temperature and the condition of each fish, however no fish would be held longer than 30 minutes from the time of capture until the time it is released, unless it had not recovered from netting stress.

Genetic Tissue Sampling

Genetic sampling would be conducted in two ways: 1) soft fin tissue sampling; and 2) telomere aging.

Soft Fin Tissues: Genetic information would be obtained from tissue samples of sturgeon helping characterize the genetic "uniqueness" and current level of genetic diversity of South Carolina populations. During processing, a small (1.0 cm^2) soft tissue sample would be collected from the trailing margin of soft tissue of one of the pectoral fins using sharp sterilized scissors and would be preserved in individually labeled vials containing 95% ethanol. The researcher has agreed to provide genetic tissue samples collected from shortnose sturgeon for archival purposes to NOAA/NOS in Charleston, South Carolina, and to Co-investigators identified in the permit. Proper certification, identity, and chain of custody of samples would be maintained during transfer of tissue samples.

Telomere Aging: Development and testing of a telomere length aging technique would utilize previously collected tissue samples and would take place within a laboratory or office setting. Approximately 200 shortnose sturgeon tissue samples of known age individuals are already compiled from past SCDNR sturgeon studies and available for the development of the aging tools. Other samples archived from past cooperative research projects along the Southeast U.S. Coast would also be a source of additional samples for this project, including larval through adult senescent stages for each species. No additional field sampling would be required. One hundred animals would be used to test whether telomere length can be used to age these species. Initial analysis of telomere length would be performed using TeloTAGGG Telomere Length Assay kits (Roche Applied Science; Mannheim, Germany) following the manufacturers specifications. Following the development of the standard age curve for the species, an additional twenty known-age samples would be used to test the reliability of the curve in age prediction.

PIT Tags

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

Dart Tags

In addition to receiving PIT tags, captured sturgeon would be tagged externally with dart tags in an effort to incorporate incidental recaptures by commercial or recreational fishermen and other researchers to make possible collection of information useful for the assessment of the sturgeon population. In all captured shortnose sturgeon, dart tags would be anchored in the dorsal fin musculature base and inserted forwardly and slightly downward from the left side to the right through the dorsal pterygiophores. After removing the injecting needle, the tag would be spun between the fingers and gently tugged to be certain the tag is locked in place. During the study, the rate of dart tag retention would be documented and reported to NMFS in annual reports.

Acoustic Transmitter Implantation Including Surgery and Anesthesia

A maximum of 20 adults (> 560 mm) and juvenile (300-560 mm) shortnose sturgeon annually would be internally acoustically tagged from each river and Lake Marion (total of 110 annually). The total weight of tags would not exceed 2 percent of the fish's total body weight. Thus, dependent upon the weight of individual fish, sturgeon would be tagged with VEMCO V7-4L; V9-6L; V13-1H; or V16-5H tags. Specifications for these transmitters are listed in Table 3 below.

Table 3: Proposed Vemco acoustic tag models and specifications

Model	Length	Diameter	Weight (H^20)	Weight (O^2)
V7-4L	22.5 mm	7 mm	1.0 g	1.8 g
V9-6L	21.0 mm	9 mm	1.6 g	2.9 g
V13-1H	36.0 mm	13 mm	6.0 g	11.0 g
V16-5H	95.0 mm	16 mm	16.0g	36.0 g

Surgery for Implanting Acoustic Tags: The following 4 to 6 minute transmitter implantation surgery under anesthesia would be used. No surgery above 27°C or below 7°C would take place. Just prior to the procedure, the candidate sturgeon would be removed from an anesthetic bath

(described below) and placed on a moist surgery rack. A tube supplying fresh water over the gills would be placed in the mouth of the fish maintaining respiration. The incision site for implanting the tag (40 to 60 mm anterior to the pelvic fins, although the specific location would vary with fish size) would be disinfected with a 10 percent iodine solution. A sterile surgical packet containing all surgical instruments and supplies would be used to make a 10 mm incision. A sterilized sonic transmitter (manufactured with an inert polymer compound) would be inserted into the surgical openings of sturgeon and the incision closed with uninterrupted suturing and treated with iodine to help prevent infection. Post-surgery fish would be held in an aerated holding tank and/or released into the net pen for recovery. Estimated surgical procedure and total holding time would be no more than 20 minutes (including typical anesthesia induction, surgery and recovery). Further, internal tags would not be implanted in unhealthy or stressed fish or pre-spawning fish in the spring.

Anesthesia for Implanting Acoustic Tags: Shortnose sturgeon selected for transmitter implantation, would be netted at temperatures 27ºC or below and 7ºC or above. Each sturgeon prepared for surgery would be anaesthetized using a bath solution of up to 150 mg/L of tricaine methane sulfonate (MS-222) buffered to neutral pH with sodium bicarbonate. Upon reaching a sedated anesthesia stage (i.e., slow movement and reduced breathing) animals would be removed from the solution and placed on a surgery rack to implant the tag. The anesthetic's induction and surgery would vary between 5 and 8 minutes, but would be appropriate for shortnose sturgeon under the specific water temperature and oxygen conditions present (Fox *et al*. 2000).

Laparoscopic Examination Including Anesthesia, Gonad Biopsy, and Blood Collection of Adults

A variety of waterborne pollutants have been linked to adverse health or reproductive changes in fish, including altered gonadal development, changes in hormone concentrations, and production of female-specific proteins (e.g., vitellogenin) in male fish. The current health and reproductive status of shortnose sturgeon and level of estrogenic activity of pollutants in the tributaries they occupy are unknown. Mark Matsche, a CI on the applicant's previous permit (NMFS, Permit No. 1505) and the proposed permit, would analyze blood samples in the lab for testosterone, estradiol, vitellogenin and hematological ranges.

Laparoscopic Surgery: The proposed action would determine the sex and reproductive health by taking gonad biopsies of 24 adult shortnose sturgeon captured annually from the Cooper River. Using sterile technique, a small (~5 mm) incision would be made in the ventral body wall slightly off midline at a level midway between the pectoral girdle and the cloaca through which a 5-mm trocar would be inserted. A 5 mm rigid laparoscope would then be inserted through the trocar to allow visualization of gonads to determine sex and reproductive health of the animal. If necessary, the body cavity would be insufflated with ambient air by attaching a battery-powered air pump to the insufflation port of the trocar increasing the working space within the body cavity. For each animal, a modified version of a quantitative health assessment index for rapid evaluation of fish (Adams *et al*. 1993) would be made in a standardized fashion so results could be compared between individuals. Determination of the sex and reproductive status of the animal would be made and recorded. In those instances where the sex of the animal is not readily apparent, a biopsy of the gonad would be taken.

Biopsy Procedure: Used in conjunction with laparoscopic surgery, a biopsy of gonadal tissue would be performed by making a second incision midway between the first laparoscopic incision and the pectoral girdle on the lateral aspect of the body approximately 1 cm dorsal to the ventral scutes. A second 5 mm trocar would then be inserted through the new incision, followed by a laparoscopic biopsy instrument to perform the biopsy. The sample would be approximately 5 mm in size (2-3g sample) and would be placed in 10% neutral, buffered formalin for preservation. Upon completion of the biopsy, the body cavity and biopsy site would be visually assessed ensuring no hemorrhaged tissue would require additional attention. The laparoscope and the two trocars would then be removed and the incisions would be closed using a single suture in a cruciate pattern.

Anesthesia for Laparoscopic Surgery: The anesthesia with laparoscopy would be rapidly induced using a buffered solution of 250 mg/L MS-222 followed by a maintenance dose of 87.5 mg/L MS-222. Each animal chosen for examination (up to 24 proposed annually from the Cooper River) would be selected in excellent, non-stressed condition when netted. When removed from the net, each fish would be transported to a near-by field laboratory (two to three minute transport) providing a 110-v electrical outlet to operate the lab and surgical equipment. Upon arrival, the animal would be anesthetized with a 250 mg/L solution of buffered MS-222, fitted with a heart rate monitor assisting researchers determining when a state of surgical anesthesia has been reached, the point when the fish exhibits complete loss of equilibrium, decreased muscle tone and reaction to massive stimulation, while maintaining a depressed ventilation rate and a regular heart rate (Ross and Ross 1999; Summerfelt and Smith 1990, and Kahn and Mohead 2010). Just prior to the procedure, the animal would be positioned in lateral recumbence within a recirculating anesthesia machine delivering a maintenance dose of 87.5 mg/L buffered tricaine over the fish's gills. The time required to reach the proper stage of anesthesia would average 2 to 7 minutes (Matsche; unpublished data).

*Blood Collection***:** Blood would be collected from the caudal veins of 24 shortnose sturgeon adults annually to ascertain if estrogenic compounds might be adversely affecting the shortnose sturgeon population. 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). Needle and syringe size, as well as blood volume collected, would be dependent on the fish size, as presented below in Table 4.

Table 4: Needle and syringe sizes proposed based on fish weight

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

Each blood sample would be divided equally between two tubes, one tube containing the anti-coagulant lithium heparin and one tube containing none. Blood samples would then be centrifuged and placed in a cool dry place until they could be transferred by common carrier to CI identified in the permit for diagnostic work. In addition, a blood smear would be made at this time.

II. PERMIT CONDITIONS

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

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

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

3. The Permit Holder may use visual images collected under this permit, including those authorized in Appendix 1, in printed materials (including commercial or scientific publications) and presentations provided images are accompanied by a statement indicating that the activity depicted was conducted pursuant to Permit No. 15677. This statement must accompany all images in subsequent uses or sales.

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

    a. Where such non-essential photography, filming, or recording activities are authorized they must not influence the conduct of permitted activities in any way or result in takes of protected species.

    b. Personnel authorized to accompany the Researchers during permitted activities for the purpose of non-essential photography, filming, or recording activities are not allowed to participate in the permitted activities.

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

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

a. *Capturing*:

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

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

iii. Gear may be deployed only in waters where D.O. levels $\geq$ 4.0 mg/L at the deepest depth sampled by the gear while deployed.

iv. Netting may take place between 0°C and 28 °C; however, at water temperature > 27°C, or < 7°C, authorized procedures must be non-invasive (e.g., PIT and Dart tag, measure, weigh, photograph, and genetic tissue clip).

v. At water temperatures above 25°C $\leq$ 28°C, nets may be set for up to one hour duration and must be tended.

vi. At water temperatures above 20°C $\leq$ 25°C, nets may be set for up to two hours duration and must be tended.

vii. At water temperatures above 15°C $\leq$ 20°C, nets may be set for up to four hours duration and must be tended.

viii. At water temperatures between 0 $\leq$ 15°C, nets may be fished for up to10 hours, and must be tended in daylight hours.

ix. At water temperatures between 0 $\leq$ 15°C (between November and March), unattended nets may be set for up to 14 hours duration in the Edisto River at or above river mile 40;

x. Trawls may be towed at an average speed of 3 to 5 mph for no more than 10 minutes.

xi. A depth sounder/global positioning system must be used to monitor trawling position to minimize disturbance of the substrate while

xii. trawling. Trawls may not cover the same area within a 24 hour period.

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

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

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

b. *Holding and Handling*:

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

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

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

iv. Sturgeon overly stressed from capture must be resuscitated and/or allowed to recover inside a net pen or live well and released without further handling. However, at the discretion of the researcher, PIT tagging, Dart tagging, genetic tissue sampling, weighing, measuring and/or photographing may be done prior to release.

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

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

vii. The total holding time of shortnose sturgeon after removal from capture gear until they are returned to the water, must not exceed two hours, except when water temperatures > 27°C; then holding time must not exceed 30 minutes, unless fish have not recovered from stress.

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

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

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

xi. Sturgeon are extremely sensitive to chlorine; therefore, thorough flushing of holding tanks sterilized with bleach is required between sampling periods.

c. *Egg/ Larvae Collection with Artificial Substrates (Buffer Pads)*:

i. Up to 50 eggs and/or larvae may be collected annually using artificial substrates in each the Savannah River or Lake Marion and its tributaries. Any additional eggs must be returned to the site of collection.

ii. Eggs or larvae collected by substrate may be preserved and transported back to the lab.

iii. Once the total number of eggs and/or larvae authorized has been taken annually, artificial substrates must be removed from the river and sampling may not be resumed until the following year.

iv. All artificial substrates must be removed from the river upon completion of this project or by the expiration date of this permit, whichever comes first.

d. *Genetic Tissue Sampling*:

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

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

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

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

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

e. *Tagging Conditions*:

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

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

iv. PIT tags should be injected in the left, dorsal musculature just anterior to the dorsal fin with the copper antenna oriented up for maximum signal strength and then scanned after implantation to ensure proper tag function. PIT tags may also be inserted under scutes after discussing with NMFS.

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

vi. The rate of PIT tag and Dart tag retention and the condition of

recaptured sturgeon at the site of tag injection should be documented during the study with results reported to NMFS in annual and final reports.

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

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

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

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

f. *Anesthetization*:

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

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

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

iv. Researchers may use MS-222 at concentrations up to 150 mg/L when anesthetizing shortnose sturgeon for implanting acoustic transmitters; and may use up to 250 mg/L when anesthetizing shortnose sturgeon for laparoscopic examinations.

v. When anesthetizing shortnose sturgeon with concentrations of MS-222 above 150 mg/L, researchers must observe fish closely and establish the proper level of anesthesia using a heart monitor.

vi. Should a researcher encounter a sudden reflex reaction while performing a surgical procedure on an anesthetized sturgeon, the procedure should be stopped and the level of anesthesia reevaluated before proceeding.

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

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

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

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

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

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

g. *Laparoscopic Examination, Gonad Biopsy and Blood Collection*:

i. Researchers performing laparoscopy on shortnose sturgeon must have first received supervised training on shortnose sturgeon or another surrogate species before doing so. The Responsible Party or PI must report this training to NMFS prior to the activity.

ii. Should uncontrolled hemorrhaging occur while performing laparoscopy, the procedure should be stopped and the bleeding stabilized before deciding to proceed, or else stopping the procedure and recovering the animal for release.

iii. Blood and biopsy samples may be sent for analyses to Mark Matsche at the Maryland DNR, Oxford Maryland Laboratory; and also to Barbara Hudson at the Antech Diagnostics Laboratory, Lake Success, NY.

iv. Blood and biopsy samples not consumed during testing, must be properly disposed of immediately after all testing is completed.

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

i. Interactions with sea turtles should be documented with any pertinent detail (species, type of interaction, location, date, size, water & air temp, any obvious patterns and photos if possible (See Appendix 7).

ii. If a sea turtle is incidentally captured during netting, the Permit Holder, Principal Investigator, Co-investigator(s), or Research Assistant(s) must use care when handling a live turtle to minimize any possible injury; and appropriate resuscitation techniques must be used on any comatose turtle prior to returning it to the water. All turtles must be handled according to procedures specified in 50 CFR 223.206(d)(1)(i).

k. *Atlantic Sturgeon Interaction*:

i. If an Atlantic sturgeon is incidentally captured, NMFS requests it be handled as recommended by NOAA sturgeon research protocols (Kahn and Mohead 2010) and minimally PIT tagged, Dart tagged, genetically sampled, and released.

ii. Interactions should be reported as specified in Section E. 10. Also, NMFS requests Atlantic sturgeon interactions are reported to Lynn Lankshear, NMFS PR at 978-281-9300 x 6535; (Lynn.Lankshear@noaa.gov). (Appendix 5). This report should contain descriptions of take, including lethal take, location, and final disposition of the sturgeon. 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.

l. *Incidental Mortality of Shortnose Sturgeon*:

i. If a greater incidence of mortality or serious injury occurs than authorized, NMFS PR must be consulted to determine the cause of mortality and to discuss any remedial changes in research methods. The Permits Division could grant authorization to resume permitted activities based on review of the incident depending on the circumstances, or else suspend activities.

Reports

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

Reports may be submitted:

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

1. Written incident reports related to serious injury and mortality events or to exceeding authorized takes, must be submitted to the Chief, Permits Division within two weeks of the incident. The incident report must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional research-related mortality or exceedence of authorized take.

3. An annual report must be submitted to the Chief, Permits Division by August 16th for each year the permit is valid. The annual report describing activities conducted during the previous permit year must follow the format in Appendix 2.

4. A final report must be submitted to the Chief, Permits Division within 180 days after expiration of the permit, or November 16, 2016, or, if the research concludes prior to permit expiration, within 180 days of completion of the research. The final report must follow the format in Appendix 2.

5. Careful and detailed records must be kept on the time of recovery and other responses from anesthesia, handling, tissue sampling, tag retention and healing, and condition and health of any shortnose sturgeon.

6. A *Biological Sample Certification, Identification and Chain of Custody Form* (Appendix 3a) must accompany shipments of genetic tissue samples to the NOAA-NOS archive in Charleston, South Carolina. Samples must be submitted to the archive between six and twelve months after collection. Prior to air shipping tissue samples preserved in ETOH, researchers should satisfy the brief online training requirement offered by the Office of Environmental Health and Safety. See example instructions at: www.unh.edu/ehs/pdf/Shipping-Ethanol-Solutions.pdf.

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

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

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

10. NMFS requests all Atlantic sturgeon interactions are reported to Lynn Lankshear, (Lynn.Lankshear@noaa.gov or 978-281-9300 x 6535). If dead specimens are collected, this report should be documented by completing the sturgeon salvage form (Appendix 5). Specimens or body parts of dead Atlantic sturgeon should be preserved — preferably on ice or refrigeration — until sampling and disposal procedures are discussed with NMFS.

11. Research results must be published or made available to the scientific community in a reasonable period of time, or to NMFS when requested periodically.

F. Notification and Coordination

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

   Southeast Region, NMFS, 263 13th Ave South, St. Petersburg, FL 33701; phone (727) 824-5312; fax (727) 824-5309.

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

III. APPROACH TO THE ASSESSMENT

NMFS approaches its section 7 analyses of research permits through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species or on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The results of this step define the action area for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our exposure analyses). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be

exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our response analyses).

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

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

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

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

Although reductions in fitness of individuals are a necessary condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always sufficient

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

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

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

During each consultation, we conduct electronic searches of the general scientific literature using *American Fisheries Society*, *Google Scholar*, *ScienceDirect*, *BioOne*, *Conference Papers Index, JSTOR,* and *Aquatic Sciences and Fisheries Abstracts* search engines. We supplement these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically try to identify data or other information that supports a particular conclusion (for example, a study that suggests shortnose sturgeon will exhibit a particular response to D.O. concentrations) as well as data that does not support that conclusion. When data are equivocal, or in the face of substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action would not have an adverse effect on listed species when, in fact, such adverse effects are likely.

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

IV. Description of the Action Area

The SCDNR would sample and track endangered shortnose sturgeon in river systems throughout the state of South Carolina (See Figure 1 and 2 below) including: Savannah River; ACE Basin (including the Ashepoo, the Combahee and the Edisto Rivers); Cooper River; Santee River, Lake Marion and its tributaries (including the Saluda River, Broad River, Congaree River and Wateree River) and the Winyah Bay watershed (including the Black, Waccamaw, Sampit, Little Pee Dee and Great Pee Dee Rivers). Netting activities with anchored and drift gill nets, trammel nets and trawls would be carried out in rivers between the fresh and saltwater interface and up to river kilometer 200, or up to the first impassable dam (Figure 1). Research vessels would also pass through and over the water column between river kilometer 0 and 200 while transiting to collect data from telemetry receivers. Locations of fixed telemetry positions appear in Figure 2.

The map of the action area is highlighted in Figure 1 and 2 below and is also illustrated online at: http://maps.google.com/maps/ms?ie=UTF8&hl=en&msa=0&msid=113286167511014551758.00048f4724bacf8629924&ll=32.852678,-80.19702&spn=1.68432,2.469177&t=h&z=9

Figure 1: Map of South Carolina Rivers and proposed gill netting and trawling locations.

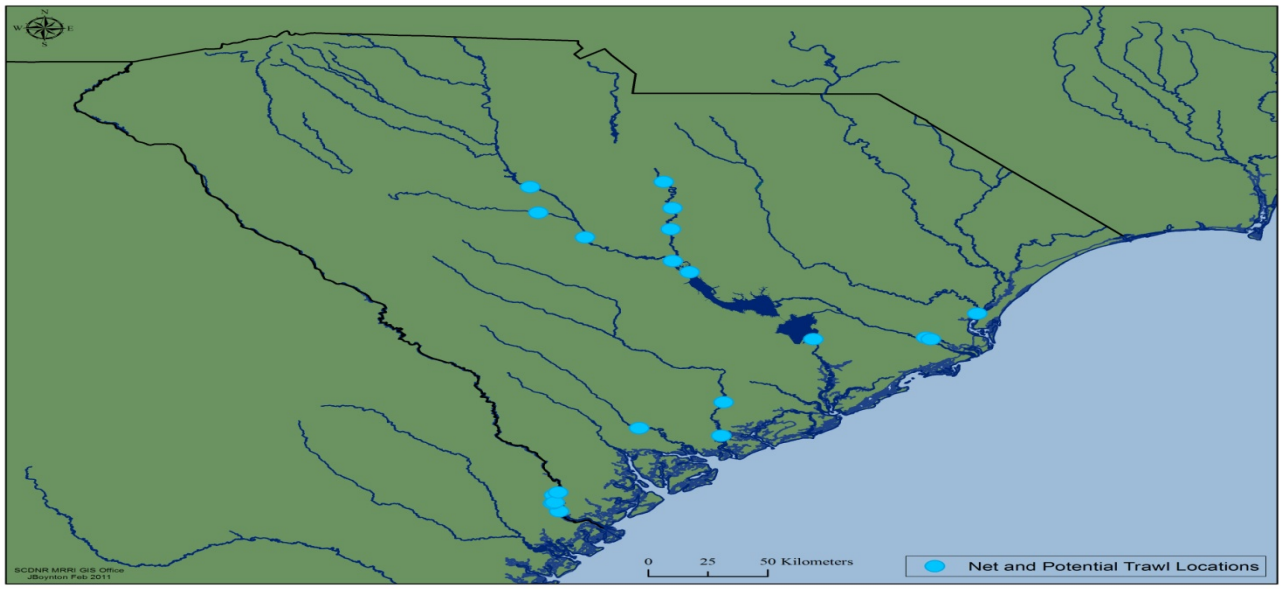
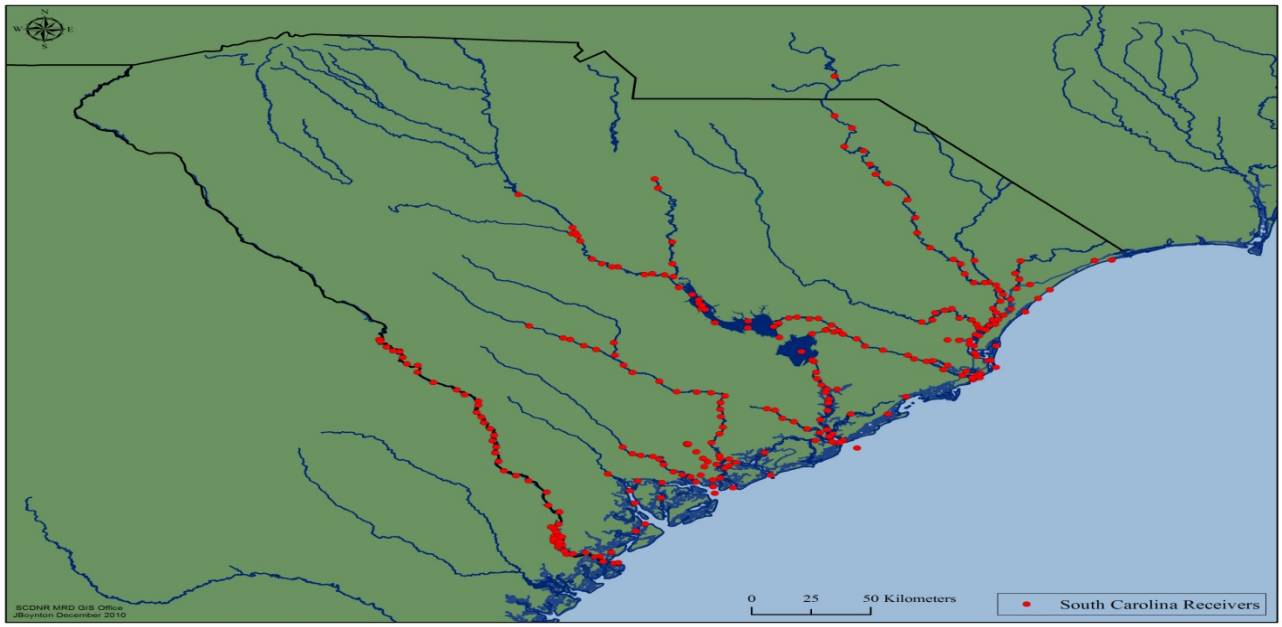


Figure 2: Map of South Carolina Rivers and locations of fixed telemetry positions.



V. STATUS OF THE SPECIES/CRITICAL HABITAT

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

Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Green sea turtle	*Chelonia mydas*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
North Atlantic right whale	*Balaena glacialis*	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).

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

A. Listed Resources Not Considered Further in this Opinion

Sea Turtles: Five species of sea turtles (listed above) have been documented in South Carolina waters, however, occurrences of the hawksbill sea turtle are very rare within the action area due to their preferred feeding habits on sponges and corals (not abundant in South Carolina waters). Also, although leatherback sea turtles have been documented in the lower Cape Fear River, located north of the action area, they occur almost exclusively in open ocean waters (J. McNeill, pers. comm. to Malcolm Mohead, 2011). However, because green turtles, Kemp's ridley and loggerheads are more specialized feeders, grazing on sea grasses and algae in coastal environment (estuaries, bays and inter-coastal waterways), they potentially could be impacted by boating activities of researchers while in transit to sonic receivers locations in the more brackish waters of estuaries. Sea turtles do not frequently travel upriver to the fresh water locations where netting and trawling activities are proposed. NMFS PR3 believes it is unlikely that a sea turtle would co-occur with netting activities. Therefore, sea turtles are not discussed further in this Opinion.

Cetaceans: Federally endangered humpback, sei and northern right whales are found seasonally (fall and winter) off-shore in deeper waters of South Carolina; however these animals are not known to occur in near-shore areas of South Carolina. As such, NMFS PR3 has determined these listed whales would not likely to occur in the action area where research activities would occur. During all boating activities (including travel to acoustic receiver arrays) researchers would be advised to keep a close watch for all marine mammals to avoid harassment or interaction and also advised to review the NMFS Southeast Region Marine Mammal Approach and Viewing Guidelines located online at (http://www.nmfs.noaa.gov/pr/education/regional.htm#se). Because the proposed activities are unlikely to impact marine mammals, they are not discussed further in this Opinion.

B. Status of Species Considered in this Opinion

Species Description, Range-wide Distribution, and Population Structure. Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada to the St. Johns River in Florida. The Shortnose Sturgeon Recovery Plan describes 20 shortnose sturgeon population segments that exist in the wild. Two additional geographically distinct populations occur behind dams in the Connecticut River (above the Holyoke Dam) and in Lake Marion on the Santee-Cooper River system in South Carolina (above the Wilson and Pinopolis Dams). Although these populations are geographically isolated, genetic analyses suggest that individual shortnose sturgeon move between some of these populations each generation (Quattro *et al.* 2002, Wirgin *et al.* 2005).

At the northern end of the species' distribution, the highest rate of gene flow (which suggests migration) occurs between the Kennebec and Androscoggin Rivers. At the southern end of the species' distribution, populations south of the Pee Dee River appear to exchange between 1 and 10 individuals per generation, with the highest rates of exchange between the Ogeechee and Delaware Rivers (Wirgin *et al.* 2005). Wirgin *et al.* (2005) concluded that rivers separated by more than 400km were connected by very little migration while rivers separated by no more than 20km (such as the rivers flowing into coastal South Carolina) would experience high migration

rates. Coincidentally, at the geographic center of the shortnose sturgeon range, there is a 400km stretch of river with no known populations occurring from the Delaware River, New Jersey to Cape Fear River, North Carolina (Kynard 1997). However, shortnose sturgeon are known to occur in the Chesapeake Bay, and may be transients from the Delaware River via the Chesapeake and Delaware Canal (Skjeveland *et al.* 2000, Welsh *et al.* 2002) or remnants of a population in the Potomac River.

Several authors have concluded that shortnose sturgeon populations in the southern end of the species geographic range are extinct. Rogers and Weber (1994), Kahnle *et al.* (1998), and Collins *et al.* (2000) concluded that shortnose sturgeon are extinct from the St. Johns River in Florida and the St. Marys River along the Florida and Georgia border. Rogers and Weber (1995b) also concluded that shortnose sturgeon have become extinct in Georgia's Satilla River.

Table 5: Estimated shortnose sturgeon population densities.

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
Saint John River	New Brunswick, Canada	1973/1977	18,000	30%	Dadswell 1979
Kennebecasis River	Canada	1998 – 2005	2,068	801 - 11,277	COSEWIC 2005
Penobscot River	ME	2006 - 2007	1,049	673 – 6,939	Univ. Maine 2008 SJ Fernandes - 2008
Kennebec River	ME	1977/1981	7,200	5,046 - 10,765	Squiers *et al.* 1982
		2003	9,500	6,942 - 13,358	Squiers 2003
Androscoggin River	ME		7200	5000 - 10,800	Squiers *et al.* 1993
Merrimack River	MA	1989 – 1990	33	18 - 89	NMFS 1998
Connecticut River Above Holyoke Dam		1976 – 1977	515	317 - 898	Taubert 1980, NMFS 1998
		1977 – 1978	370	235 - 623	Taubert 1980, NMFS 1998
		1976 – 1978	714	280 – 2,856	Taubert 1980, NMFS 1998
		1976 – 1978	297	267 - 618	Taubert 1980, NMFS 1998
Connecticut River Below Holyoke Dam		1988 – 1993	895	799 – 1,018	Savoy and Shake 1992
		1998-2002	-	1,042 - 1,580	Savoy 2004

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
		2003	-	1,500 - 1,800	Connecticut DEP 2003
Hudson River	NY	1980	30,311		Dovel 1979, NMFS 1998
		1995	38,000	26,427 - 55,072	Bain *et al.* 1995, NMFS 1998
		1997	61,000	52,898 - 72,191	Bain *et al.* 2000
Delaware River	NJ, DE, PA	1981/1984	12,796	10,288 - 16,367	Hastings *et al.* 1987
		1999/2003	12,047	10,757 - 13,589	Brundage and O'Herron 2003
Chesapeake Bay	MD, VA	no data	-	-	
Potomac River	MD, VA	no data	-	-	
Neuse River	NC	2001-2002	extirpated		Oakley 2003, Oakley and Hightower 2007
Cape Fear River	NC	1997	>100		Kynard 1997, NMFS 1998
Winyah Bay	NC, SC	no data	-	-	
Waccamaw - Pee Dee River	SC	no data	-	-	
Santee River	SC	no data	-	-	
Lake Marion (dam-locked)	SC	no data	-	-	
Cooper River	SC	no data	-	-	
ACE Basin	SC	no data	-	-	
Savannah River	SC, GA		1,000 - 3,000		Bill Post, SCDNR 2003
Ogeechee River	GA	1990s	266		Bryce *et al.* 2002
		1993	266	236 - 300	Kirk *et al.* 2005
		1993	361	326 - 400	Rogers and Weber 1994
		1999/2000	195	-	Bryce *et al.* 2002
		2000	147	105 - 249	Kirk *et al.* 2005
		2004	174	97 - 874	Kirk *et al.* 2005
		2008	368	244-745	Kirk 2008 NMFS Ann. Report
Delaware River	GA	1988	2,862	1,069 - 4,226	NMFS 1998
		1990	798	645 – 1,045	NMFS 1998

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
		1993	468	315 - 903	NMFS 1998
		2003-2005	6,320	4,387-9,249	DeVries 2006
Satilla River	GA		unknown	-	Kahnle *et al.* 1998
Saint Marys River	FL		unknown	-	Kahnle *et al.* 1998, Rogers and Weber 1994
Saint Johns River	FL	2002	1	-	FFWCC 2007

In addition to these wild populations there are several captive populations of shortnose sturgeon (Table 6). 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 6: Populations reared in captivity

Conte Fish Research Center	MA
Bear's Bluff hatchery	SC
Orangeburg hatchery	SC
Warm Springs hatchery	GA

Life History Information. Shortnose sturgeon are anadromous fish that live primarily in slower moving rivers or nearshore estuaries near large river systems. They are benthic omnivores that feed on crustaceans, insect larvae, worms, and 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 was first listed on the International Union for Conservation of Nature and Natural Resources Red List in 1986 where it is still listed as Vulnerable and facing a high risk of extinction based in part on: an estimated range reduction of greater than 30% over the past three generations, irreversible habitat losses, effects of habitat alteration and degradation, degraded water quality and extreme fluctuations in the number of mature individuals between rivers.

Status and Trends of Shortnose Sturgeon Populations. Despite the longevity of adult sturgeon, the viability of sturgeon populations are highly sensitive to juvenile mortality that result in reductions in the number of sub-adults that recruit into the adult breeding population (Anders *et al.* 2002, Gross *et al.* 2002, Secor *et al.* 2002). This relationship caused Secor *et al.* (2002) to conclude that sturgeon populations can be grouped into two demographic categories: populations that have reliable (albeit periodic) natural recruitment and those that do not. The shortnose sturgeon populations without reliable natural recruitment are at the greatest risk.

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

Based on the information available, most shortnose sturgeon populations in the northern portion of the species range, from Delaware River north to the St. John River in Canada, appear to have sufficient juvenile survival to provide at least periodic recruitment into the adult age classes

combined with relatively low adult mortality rates sufficient to maintain the viability of most of these populations. As a result, most of these populations appear to be relatively large and stable.

Shortnose Sturgeon in South Carolina Waters. The population status of shortnose sturgeon in coastal rivers of South Carolina from the Savannah River to the Winyah Bay System is not well documented (NMFS 1998). However, the system with the largest population estimate in South Carolina is the Savannah River; and, while the estimate is not precise, it is believed to be approximately 3,000 (NMFS 2004). It is assumed this population is influenced by a stocking trial in the 80's and 90's during which approximately 97,000 shortnose sturgeon were stocked to evaluate the potential for stock enhancement (Smith *et al.* 2002). However, spawning adults, as well as juvenile shortnose sturgeon, have been captured in the Savannah River. Additionally, prior to 1994 there were very few authenticated records of shortnose sturgeon in the ACE basin and only one record in the lower Ashepoo River (Smith and Collins 1996). However, more current investigations indicate the Savannah and Edisto River shortnose sturgeon populations are similar genetically (Quattro *et al.* 2002). Moreover, this evidence suggests that the current Edisto River shortnose sturgeon population has received a major contribution from Savannah River animals with the Edisto population gradually increasing over the past 10 to 15 years (McCord 2003). Otherwise, the current status of sturgeon stocks in the ACE Basin is poorly understood.

Winyah Bay, the Santee River, and the Cooper River have similar situations in terms of shortnose sturgeon records with no legitimate estimates currently recognized. Collins and Smith (1997) recorded 282 shortnose sturgeon occurrences throughout the Winyah Bay drainage area. It is thought this large basin may currently provide sturgeon access to the vast majority of their historical range of spawning and early nursery habitat was identified by Mills (1826). Presumably, spawning of both Atlantic and shortnose sturgeon presently occurs over more than 200 km (100 mi) of river mainstream in suitable channel habitats in this basin. Available data indicate the presence of spawning stocks of both sturgeons in the basin, but the extent of basin-wide distribution and habitat utilization is also largely unknown (Collins and Smith 1997).

The Santee basin has the second largest drainage area and total discharge of all river systems on the east coast of the United States (Hughes 1994). However, this large watershed has been impacted by damming to a greater extent than most basins on the Atlantic coast of North America, having 88 percent of the river's annual flow diverted into the Cooper River from 1942 through 1985 (Kjerfve and Greer 1978). With the construction of the Santee-Cooper lakes in the 1940's, the vast majority of the Santee was closed to migratory fishes. The navigational lock at Pinopolis Dam has been shown to be very ineffective at passing shortnose sturgeon (Cooke *et al.* 2002; Timko *et al.* 2003). During the approximately 40 years since the impoundment of the Santee River, average flows in the Santee River seaward of Wilson Dam have been greatly reduced from historical levels (Kjerfve and Greer 1978) with stocks of migratory fish severely impacted. The Santee and Cooper Rivers combined have had only 29 reports of sturgeon passage since the early 1990s (Collins and Smith 1997). Several hundred adults are believed to inhabit the Cooper River and fertilized eggs have been collected below Pinopolis Dam (Cooke *et al*. 2002). However, neither larvae nor juveniles have been collected and successful reproduction has not been confirmed below the dams (Cooke and Leach 2004).

Above the Santee River watershed dams, a dam-locked population of shortnose sturgeon is present in Lake Marion and its tributaries (Saluda, Broad, Congaree and Wateree Rivers) extending to Columbia to the northwest. Radio-telemetry studies conducted by the SCDNR have provided insight into the movements and habitat use of Lake Marion shortnose sturgeon where Collins *et al.* (2003) documented migration to a spawning site on the Congaree River just south of the city of Columbia (approximately 15 miles downstream of the Saluda Project at Lake Murray). Further telemetry studies, in which Cooper River sturgeon were captured, radio-tagged, and released upstream in the Santee-Cooper Lakes, documented migration of these fish as far upstream as the old Granby Lock and Dam on the Congaree River and also near the town of Wateree, SC on the Wateree River (Bill Post, Doug Cooke, SCDNR, *pers. comm*. to Malcolm Mohead, NMFS, 2011). The old Granby Lock and Dam is located adjacent to downtown Columbia, approximately 11 miles downstream of the Saluda Project and an additional 4 miles upstream of the most upstream migration documented by Collins *et al.* (2003). Presence of shortnose sturgeon in the vicinity of Granby Lock and Dam was also confirmed by collection of a single specimen during sampling related to relicensing of Duke Energy's Catawba-Wateree Project in March 2004 (Duke Energy 2004: Catawba-Wateree Hydro Project Diadromous Fish Study Plan 2004). These studies suggest shortnose sturgeon have the ability to migrate into Piedmont reaches of the Santee Basin downstream of the Saluda Project.

Sustainability of the population within the lakes is unknown, but dam-locked sturgeon populations tend to be in poorer conditions than open river populations (Collins *et al.* 2003). The genetic relationship of animals from this population to those in the Cooper and Santee Rivers is not yet clear, though a preliminary study shows animals within the lakes and in the Cooper River to be genetically similar (Collins *et al.* 2003).

VI. ENVIRONMENTAL BASELINE

By regulation, environmental baselines for biological opinions include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR '402.02). The environmental baseline for this Opinion includes the effects of several activities that affect the survival and recovery of the listed species in the action area. The following information summarizes the primary human and natural phenomena along rivers in South Carolina that are believed to affect the status and trends of endangered shortnose sturgeon and the probable responses of the shortnose sturgeon to these phenomena.

Bycatch

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

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

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

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

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

Poaching

Poaching has been documented in the action area and there is evidence of shortnose sturgeon targeted by poachers throughout their range, and particularly where they appear in abundance (such as on spawning grounds) but the extent of the poaching is difficult to assess (Dadswell 1979, Dovel *et al.* 1992, Collins *et al.* 1996). There have been several documented cases of shortnose sturgeon caught by recreational anglers. One shortnose sturgeon illegally taken on the Delaware River was documented by a New Jersey Department of Fish and Wildlife conservation officer in Trenton New Jersey (NJCOA 2006). Additionally, citations have been issued for illegal recreational fishing of shortnose in the vicinity of Troy, New York on the Hudson River and on the Cooper River in South Carolina.

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

Dams and Water Diversion

Dams are used to impound water for water resource projects such as hydropower generation, irrigation, navigation, flood control, industrial and municipal water supply, and recreation.

Dams can have profound effects on diadromous fish species by fragmenting populations, eliminating or impeding access to historic habitat, modifying free-flowing rivers to reservoirs and altering downstream flows and water temperatures. Direct physical damage and mortality can occur to diadromous fish that migrate through the turbines of traditional hydropower facilities or as they attempt to move upstream using fish passage devices. The construction of dams throughout the shortnose sturgeon's range is probably the main factor reducing their reproductive success which, in turn, could be the primary reason for the reduction in population size for shortnose sturgeon. As presented in the Status of the Species section above, a dam-locked population of South Carolina shortnose sturgeon is present in Lake Marion and its tributaries (Saluda, Broad, Congaree and Wateree Rivers) extending to Columbia, South Carolina to the northwest.

Water Quality and Contaminants

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

The water quality over the range of shortnose sturgeon varies by watershed but is notably poorer in the north than in the south. The U.S. Environmental Protection Agency (EPA) published its most recent edition of the National Coastal Condition Report (NCCR III) in 2008, a "report card" summarizing the status of coastal environments along the coast of the United States (USEPA 2008; See Table 7 below). The report analyzes water quality, sediment, coastal habitat, benthos, and fish contaminant indices to determine status. The overall condition of the collective coastal waters of the northeastern United States (Virginia to Maine) is fair-poor. The southeast region of the U.S. (Florida to North Carolina) received an overall grade of fair.

Table 7: Summary of the EPA NCCR III for the U.S. east coast published by the EPA (2008) grading coastal environments. (Northeast region=VA to ME; southeast region=FL to NC)

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

Chemicals such as chlordane, dichlorodiphenyl dichloroethylene (DDE), DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later consumed by benthic feeders, such as macroinvertebrates, and then work their way higher into the food web (e.g., to sturgeon). Some of these compounds may affect physiological processes and impede a fish's ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and altering other physical properties of the water body.

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

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

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

Power Plant Operations

Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. Over half of South Carolina electricity is generated by nuclear energy, and

there are four major nuclear plants in the state (Catawba, Oconee, Robinson and Summer nuclear power plants) (Center for Advanced Energy Studies, caesenergy.org).

Conservation Measures

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

The South Carolina Department of Natural Resources has several divisions that work to conserve resources in South Carolina, which include conservation measures in the following areas: fishing, hunting, land, water, and wildlife. Projects to conserve water in the state include ACE Basin National Estuarine Research Reserve and other Basin projects, clean vessel pumpout stations, estuarine and coastal assessments, aquatic nuisance species program, flood mitigation, groundwater well data, scenic rivers, and soil and water conservation districts. Wildlife conservation measures in the state include a comprehensive wildlife conservation strategy, a rare, threatened, and endangered species inventory, as well as conservation measures per species. The South Carolina land conservation measures are intertwined with the state's water conservation measures and include conservation districts, heritage preserves, and wetlands management.

Scientific Research

Shortnose sturgeon have been the focus of field studies since the 1970s. The primary purpose of this research is for monitoring populations and gathering data for physiological, behavioral and ecological studies. Over time, NMFS has issued dozens of permits for takes of shortnose sturgeon within its range for a variety of activities including capture, handling, lavage, laparoscopy, blood work, habitat, spawning verification, genetics, aging, and tracking. All scientific research permits are also conditioned with mitigation measures to ensure that the research impacts target and non-target species as minimally as possible.

Range wide, there are currently 17 active scientific research permits targeting wild shortnose sturgeon populations with similar objectives as proposed by the applicant (See Table 8) these include Permit 1505-01, the ESA permit authority the applicant currently operates under. There are also three other currently authorized research projects studying the unlisted Atlantic sturgeon and shortnose sturgeon populations in South Carolina waters, each potentially impacting shortnose sturgeon and its habitat to some extent. Permits 1542 and 1543 are held by SCANA, Inc. and Duke Energy Company, respectively, located in the upper Santee Basin. The third permit is Permit 1447 held by the South Carolina DNR researching shortnose and Atlantic sturgeon in some of the same coastal rivers as requested by the applicant. A Biological Opinion was issued for each of these the permits, including the requirement for consideration of cumulative effects to the species. For each permit, the Biological Opinion concluded that issuance, as conditioned, was not likely to jeopardize the continued existence of the shortnose sturgeon.

Table 8. Existing shortnose sturgeon research permits similar to the proposed action.			
Permit No.	**Location**	**Authorized Take**	**Research Activity**
10115 Expires: 8/3/2013	Saint Marys & Saltilla Rivers, FL & GA	85 adult/juv 20 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, collect ELS
14394 Expires: 9/30/14	Altamaha River and Estuary, GA	500 adult/juv. (1 lethal), 100 ELS	Capture, handle, weigh, measure, PIT tag, transmitter tag, tissue sample, anesthetize, laparoscopy, blood collection, fin ray section, collect ELS
10037 Expires: 4/30/2013	Ogeechee River and Estuary, GA	150 adult/juv. (2 lethal), 40 ELS	Capture, handle, measure, weigh, PIT tag, tissue sample, fin-ray section, anesthetize, laparoscopy, blood collection, radio tag, collect ELS
1447 Expires: 2/28/2012	S. Carolina Rivers and Estuaries	100 adult/juv. (2 lethal), 100 ELS	Capture, handle, measure, weigh, PIT and dart tag, transmitter tag, anesthetize, tissue sample, gastric lavage, collect ELS
1505-01* Expires: 5/15/2011	S. Carolina Rivers and Estuaries	98 adult/juv. (2 lethal), 200 ELS	Capture, handle, measure, weigh, PIT and dart tag, transmitter tag, anesthetize, laparoscopy, blood collection, tissue sample, gastric lavage, collect ELS
1542 Expires: 7/31/2011	Upper Santee River Basin, SC	5 adult/juv.; 100 ELS	Capture, handle, weigh, measure, PIT and dart tag, tissue sample, ELS collection
1543 Expires:11/30/2011	Upper Santee River Basin, SC	3 adult/juv.	Capture, handle, weigh, measure, tissue sample
14396 Expires: 12/31/2014	Delaware River and Estuary NJ & DE	100 adult/juv. (1 lethal),	Capture, handle, measure, weigh, dart tag, PIT tag, tissue sample, anesthetize, ultrasonic tag,
14604 Expires: 4/19/2015	Delaware River and Estuary NJ & DE	1,000 adult/juv (1 lethal) 500 ELS	Capture, handle, weigh, measure, PIT tag, dart tag, ultrasonic tag, tissue sample, anesthetize, laparoscopy, blood/biopsy collection, collect ELS
1547 Expires:10/31/2011	Hudson River, (Haverstraw & Newburgh), NY	500 adults/juv.	Capture, handle, weigh, measure, PIT & Carlin tag, tissue sample
1575 Expires11/30/2011	Hudson River (Tappan-Zee), NY	250 adult/juv.	Capture, handle, measure
1580 Expires: 3/31/2012	Hudson River and Estuary, NY	82 adult/juv.; 40 ELS	Capture, handle, measure, weigh, PIT tag, Carlin tag, photograph, tissue sample, collect ELS
1449 Expires: 3/31/2010	Upper Conn. River, MA	80 adult/juv.; 200 ELS	Capture, handle, measure, weigh, PIT tag, external radio tag, collect ELS

Permit No.	Location	Authorized Take	Research Activity
1549 -01 Expires: 1/31/2012	Upper Conn. River, MA	673 adult/juv (5 lethal), 1,430 ELS from East Coast rivers	Capture, handle, measure, weigh, anesthetize, PIT tag, TIRIS tag, radio tag, temperature/depth tag, tissue sample, borescope, laboratory tests, photographs, collect ELS
1516 Expires: 5/15/2011	Lower Conn. River & Estuary., CT	500 adult/juv (2 lethal); 300 ELS	Capture, handle, measure, weigh, PIT tag, sonic/radio tag, gastric lavage, fin ray section, collect ELS
1578-01 Expires: 11/30/2011	Kennebec River and Estuary, ME	500 adult/juv.; 30 ELS	Capture, handle, measure, weigh, tissue sample, PIT tag, acoustic tag, anesthetize, collect ELS
1595-04 Expires: 3/31/2012	Penobscot River and Estuary, ME	200 adult/juv. (2 lethal); 50 ELS	Capture, handle, measure, weigh, borescope, photograph, tissue sample, blood sample, Carlin tag, PIT tag, anesthetize, transmitter tag, collect ELS

Integration of the Environmental Baseline. The above activities within the action area pose threats to its shortnose sturgeon population in the following ways. Many activities cause *death* – definite removal of individual fish from South Carolina river populations – at the adult, juvenile, and larval stages. Other activities cause *injury* to shortnose, increasing stress levels and decreasing their survival potential. Still, other activities *alter habitat*, potentially changing spawning and survival patterns of these fish.

Activities potentially causing death to individual shortnose sturgeon are bycatch in commercial and recreational fishing, cooling water intakes and power plants, and research. Hydroelectric or nuclear power plants must use rivers or lakes as sources of running turbines or as cooling mechanisms. Adult and larval shortnose sturgeon are known to be killed or impinged on the screens that cover the cooling water intake screens (Hoff and Klauda 1979, Dadswell *et al.* 1984, NMFS 1993). Dadswell *et al.* (1984) reported that larval and juvenile shortnose sturgeon in the different populations along the Atlantic have been killed after being impinged on the intake screens or entrained in the intake structures of power plants on the Delaware, Hudson, Connecticut, Savannah and Santee rivers. Finally, some NMFS-permitted shortnose sturgeon research projects authorize take of early life stages and allow for 1 incidental shortnose sturgeon mortality throughout the life of the permit.

All of the activities identified in the Environmental Baseline section have the potential to injure individual shortnose sturgeon. Commercial and recreational fishing industries that catch shortnose incidentally might return living fish to the river, presumably unharmed, however each fish might have sustained injury in the process. The operation of power plants can also have unforeseen and detrimental impacts to water quality which can injure shortnose sturgeon.

Water quality changes from dredging, shipping, land use practices, point and non-point source pollution could also injure shortnose sturgeon by way of changes in D.O. concentration or introduction of waterborne contaminants. D.O. concentrations can be affected by maintenance

dredging of Federal navigation channels and other waters. Apart from entrainment, dredging can also change D.O. and salinity gradients in, and around, the channels (Jenkins *et al.* 1993, Campbell and Goodman 2004, Secor and Niklitschek 2001). Dredging operations may pose risks to shortnose sturgeon by destroying or adversely modifying their benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Since shortnose sturgeon are benthic omnivores, the modification of the benthos could affect the quality, quantity, and availability of sturgeon prey species.

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

Other NMFS-permitted research activities could also injure shortnose sturgeon. There are currently 17 research permits authorizing directed take of shortnose sturgeon. Although one gillnetting mortality has been reported recently (June 3 2010, Delaware River), no other shortnose sturgeon research mortalities have been reported since temperature and D.O. netting protocols were implemented. In addition, shortnose sturgeon could be injured in a way that is not observed or quantified by researchers.

Estimated shortnose sturgeon densities for South Carolina rivers appear in Table 9. Currently, there are only estimates for the Savannah River shortnose sturgeon.

Table 9. Shortnose sturgeon densities for South Carolina rivers.

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
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	-	-	

Population/Subpopulation	Distribution	Datum	Estimate	Confidence Interval	Authority
Savannah River	SC, GA		1,000 - 3,000		Bill Post, SCDNR 2003

VII. Effects of the Proposed Action

Pursuant to Section 7(a)(2) of the ESA, federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The permit would be valid for five years from the date of issuance and would authorize monitoring of the status of shortnose sturgeon in South Carolina rivers. The proposed permit would authorize non-lethal sampling with anchored gillnets, trammel nets and trawls, capturing up to 154 shortnose sturgeon adults and sub-adults annually from the Savannah, ACE Basin, Cooper, Santee Rivers, Winyah Bay System, and Lake Marion and its tributaries. Sturgeon taken in good condition would be measured, weighed, sampled for genetic tissue analysis, and PIT and dart tagged. Additionally, up to 110 sturgeon would be anesthetized and implanted with internal sonic transmitters annually. Sturgeon sex and general health would be determined from a sample of 24 fish annually from the Cooper River using laparoscopy, and if necessary to confirm sex, biopsies of gonad material would be taken. Afterward, blood samples would be collected and processed determining endocrine disrupters. Manual tracking and passive detections of telemetered fish at fixed receiver stations would provide information about movements and habitat use. Recaptures of tagged fish would also be used to estimate abundance when appropriate. Additionally, lethal collection of up to 50 eggs and larvae from both the Savannah River and Lake Marion and its tributaries would take place during seasonal spawning activity using artificial substrates. Finally, up to 20 young of year (YOY) and other juveniles less than 300 mm would be sampled with epibenthic trawls in Lake Marion and its tributaries, and in the Savannah, ACE Basin, Cooper, Santee, and Winyah Bay System. No annual unintended sturgeon mortality or serious harm resulting from research would be authorized. The proposed take by river and activity is summarized and broken down in Table 1.

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

A. Potential Stressors

The assessment for this consultation identified several possible stressors associated with the proposed permitted activities. These include: 1) capture by gillnet, trammel net, or trawl; 2)

handling for procedures and measurements; 3) PIT and dart tagging; 4) anesthesia; 5) genetic tissue sampling; 6) laparoscopy; 7) gonad biopsy; 8) internal sonic transmitter implantation; 9) collection of ELS; and 10) blood sampling. All adult and sub-adult shortnose sturgeon would be captured, handled, genetic tissue sampled, and PIT and dart tagged. Smaller subsets of these fish would undergo anesthesia and blood sampling for laparoscopy or internal sonic/radio tagging. Young of the year (up to 20) will be captured via trawl and 50 ELSs will be collected. Activities are expected to occur in the action area for five years until the permit's expiration. Based on a review of available information, we determined that all potential stressors listed above could pose a risk to shortnose sturgeon. Accordingly, the effects analysis of this consultation focused on all of the potential stressors listed above.

B. Exposure Analysis

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

Table 1 identifies the numbers of shortnose sturgeon that are expected to be exposed annually for five years in the action area under the proposed permit 15677. The time required to complete routine, non-invasive methods (*i.e.,* PIT tagging, measuring, weighing) would be less than two minutes per fish. After capture, fish would be allowed to recover for 10-15 minutes prior to further handling/sampling. The cumulative time required for handling/sampling procedures such as anesthetizing, telemetry tagging, and tissue sampling would vary, but would typically average less than 15 minutes per fish. Implantation of sonic/radio tag attachment would take 3-5 minutes. Laparoscopy would be conducted at an adjacent temporary field lab and is expected to take 20 minutes. Researchers would take the fish to the field lab they have set up (boating time depends on distance, but typically lasts a few minutes in the holding tank with supplemental oxygen) and place the sturgeon under anesthetic (2-5 minutes); conduct the laparoscopy, take blood, and suture (2-3 minutes); and then release it to a holding net/net pen after coming out of anesthesia (5-7 minutes). All fish would be treated with a slime coat restorative and, if anesthetized, or otherwise necessary, placed in a separate net pen to ensure full recovery prior to release.

C. Response Analysis

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

Capture. Up to a total of 154 adult and sub-adult shortnose sturgeon would be captured annually using a standardized netting protocol with anchored or drift gillnets, trammel nets, and

trawls in the action area. Anchored gillnets of 12.7 com (5 inches) or trammel nets with inner mesh of 8.89 cm (3.5 inches) stretched mesh and outer mesh of 38.1 cm (15 inches) would be used to sample adults. Nets would typically measure 92 m long by 1.8 m deep, although shorter nets may sometimes be used depending on the area of deployment. Trawling would be conducted in the configuration of a Missouri Trawl (McCord *et al.* 2007) 16 feet at the headrope to 3 feet at the mid section to 1.25 feet at the cod (distal) end. The footrope of the trawl is 18 feet long, and a 0.375 inch diameter chain would be attached. A standard trawl haul would be 300 to 500 feet lasting approximately 10 to 15 minutes at 3-5 miles per hour.

Nets

Entanglement in gillnets could result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Moser and Ross 1995, Collins *et al.* 2000, Moser *et al.* 2000, Kahn and Mohead 2010). Hightower *et al*. (2002) experienced one Gulf sturgeon mortality in 1997 with gillnetting and Mason and Clugston (1993) experienced some mortality in their gillnets. Recently, on June 3 2010, Hal Brundage experienced one shortnose sturgeon gillnet mortality in the Delaware River (7.7 ppm D.O., 26.7C, in a 90 minute net set). The shortnose sturgeon was a post spawner and was 772 mm weighing about 2.9kg (6.5 lbs), which is a fairly small fish. It was also the fish's first time captured. However, historically, the majority of shortnose sturgeon mortality during scientific investigations has been directly related to netting mortality and as a function of numerous factors including water temperature, low D.O. concentration, soak time, mesh size, net composition, and netting experience.

To illustrate, shortnose sturgeon mortality resulting from six similar scientific research permits utilizing gillnetting is summarized in Table 10 below. Mortality rates due to the netting activities ranged from 0 to 1.22%. Of the total 5,911 shortnose sturgeon captured by gill nets or trammel nets, only 23 died, yielding an average incidental mortality rate of 0.39%. However, all of the mortalities associated with these permits were due to high water temperature and low dissolved oxygen (DO) concentrations. Moser and Ross (1995) reported gill net mortalities approached 25% when water temperatures exceeded 28ºC even though soak times were often less than 4 hours.

Table 10: Number and percentage of shortnose sturgeon killed by gill/trammel nets and trawls associated with scientific research permits prior to 2005

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

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

Under separate NMFS Permit No. 1247, between 4 and 7% of the shortnose sturgeon captured died in gillnets prior to 1999, whereas between 1999 and 2005, none of the more than 600

shortnose sturgeon gillnetted died as a result of their capture. Also, in five years, under Permit Number 1189, none of the sturgeon captured died. Under Permit Number 1174, all seven of the reported shortnose sturgeon mortalities occurred during one sampling event. Since 2006, more conservative mitigation measures implemented by NMFS and researchers (e.g. reduced soak times at warmer temperatures or lower D.O. concentrations, minimal holding or handling time), have reduced the effects of capture by gillnetting on sturgeon significantly (Table 11). To limit stress and mortality of sturgeon due to gillnetting, methods in the proposed research would adopt these more conservative measures for gillnetting (discussed further in the section below). This analysis indicates that, if done in accordance with the NMFS's sturgeon protocols (Moser *et al.* 2000, Kahn and Mohead 2010), gillnetting for shortnose sturgeon could be done with lowered risk of direct mortality.

In 2005, NMFS PR updated an analysis of previous research results and again updated permit conditions reducing the stress and mortality to shortnose sturgeon during capture. Since that time, there have been only two recorded mortalities caused during their capture using the newer NMFS protocols (See Table 11 below). As state previously, the primary causes of mortality identified during a review of permits issued prior to 2005 were high temperatures, low dissolved oxygen, long net set durations and complete occlusion of gills by mesh causing asphyxiation. The two instances of mortality since 2005 were caused by pulling a snagged net free while a fish was tangled, and another case of occluded gills.

Table 11: Number of shortnose sturgeon mortalities under recent scientific research permits

Permit Number	Shortnose sturgeon captured	Shortnose sturgeon mortalities
1420 (2005-2009)*	1472	0
1447 (2006-2010)	107	0
1444 (2005-2009)*	1	0
1449 (2007-2009)*	50	0
1486 (2006-2009)*	416	0
1505 (2006-2010)	279	0
1516 (2007-2010)	344	0
1547 (2006-2010)	150	0
1549 (2006-2010)	522	0
1575 (2007-2010)	14	0
1580 (2007-2010)	112	0
1595 (2007-2010)	695	1
10037 (2007-2010)	235	0
10115 (2008-2010)	12	0
14394 (2010)	383	
14604 (2010)	34	1
14759 (2010)	0	0
Totals	4,826	2

*Permit currently expired

Despite the success of permit modifications reducing mortality of sturgeon, there is potential for undocumented delayed mortality. Although there is no way to estimate the rate of delayed mortality, NMFS believes it would be small based on reports of various species of sturgeon captured and transported to rearing facilities.

Trawls
Capture by trawl could result in similar effects to shortnose sturgeon as reported above. NMFS protocols (Kahn and Mohead 2010) outline recommendations for trawl capture, and researchers under the proposed permit would adhere to these protocols. A standard haul should be approximately 300 to 500 feet, lasting approximately 10 minutes, and towed at a range of three to five knots (Gutreuter *et al.* 1995). At 10-15 minutes and 3-5 mph, the proposed research is relatively close to this standard haul range. This reduced speed and haul time minimizes the amount of time and severity of entanglement that occur for captured fish. Because researchers would be conducting trawls within recommended protocols, we expect a minimal risk of direct mortality.

Expected Response to Capture. As demonstrated above, there is a chance that shortnose sturgeon could die in nets, but mitigation measures included in the proposed activities should reduce the risk associated with sturgeon capture. To limit stress and mortality of sturgeon due to capture, the researchers have agreed to NMFS PR's more conservative recent set of netting conditions. Specifically, during lower water temperatures (<15°C), soak times of nets would not exceed 14 hours; at water temperatures between 15°C and 20°C, net sets would not exceed 4 hours; at water temperatures between 20°C and 25°C, net sets would not exceed two hours; and at water temperatures above 25°C, net sets would not exceed one hour and netting activities would cease at 28°C or higher. Gear would be deployed only in waters where dissolved oxygen concentrations are at least 4.5 mg/l at the deepest depth sampled by the gear for the entire duration of deployment. Hauls are well within recommended protocols for research on sturgeon. Lastly, related to capture, while it is possible that interaction with the capture methods described above could result in fewer adults reaching spawning grounds—by externally tagging pre-spawning fish in the fall and winter— it is anticipated that spawning runs would not be interrupted due to timing and placement.

Therefore, the capture methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in South Carolina Rivers. By extension, capture is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the netting protocols are used and closely followed.

Handling. Up to 154 shortnose sturgeon would be handled for length and weight measurements and the other proposed methods under this proposed research authorization. Fish would be held in a box for examination, measuring, tissue sampling, and tagging. To weigh, captured shortnose sturgeon would be placed in a capture sling and suspended from a digital scale. In normal processing of most fish (i.e., those not undergoing additional procedures such as anesthesia, transmitter implants, or laparoscopy), the sling would be lowered over the side of the boat into the water, opened, and the sturgeon allowed to swim away.

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

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

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

Passive Integrated Transponder (PIT) and Dart Tags. All shortnose sturgeon captured that are previously unmarked would be marked with PIT tags and dart tags. No fish would be double-tagged with 2 PIT tags or 2 dart tags. Prior to tagging, the entire dorsal surface of each fish would be scanned to detect previous 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. Dart tags would be anchored in the dorsal fin musculature base and inserted forwardly and slightly downward from the left side to the right through the dorsal pterygiophores.

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.

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.

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

Expected Response to PIT and Dart Tags. 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 or dart 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 Henne inferred from the results that either 11.9 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 and would not use the 14 mm tags.

Therefore, the tag methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in South Carolina Rivers. By extension, 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 tags are used and tagging protocols are closely followed.

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

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

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

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

Effects of MS-222 would be short-term and only affect the target species. MS-222 is excreted in fish urine within 24 hours and tissue levels decline to near zero in the same amount of time

(Coyle *et al.* 2004). To increase absorption time and ensure a fast anesthesia process, the applicant will add sodium bicarbonate to buffer the acidic MS-222 to a more neutral pH. Therefore, at the proposed rates of anesthesia, narcosis would take one minute and complete recovery time would range from three to five minutes (Brown 1988).

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

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

Due to our review of available information and the precautions and training applicant has and will take to minimize anesthetic impacts, we believe that MS-222 anesthesia is not likely to reduce the viability of shortnose sturgeon as listed under the ESA. This conclusion can be reached as long as the appropriate concentrations of MS-222 are used and proposed duration exposure and procedures are closely followed.

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

sturgeon from this activity (Wydoski and Emery 1983) and the methodology as proposed is not likely to reduce the viability of the shortnose sturgeon population in South Carolina Rivers. By extension, genetic fin clip sampling is not likely to reduce the viability of shortnose sturgeon as listed under the ESA.

Laparoscopy. Laparoscopy is a minimally invasive surgery (MIS), or an operation performed through small incision(s) compared to larger incisions needed for traditional surgeries. In comparison to most traditional surgical procedures, MIS induces relatively minor tissue trauma, which, in most cases, results in shorter postoperative recovery periods, decreased postoperative care, and fewer postoperative complications (Cook and Stoloff 1999). Laparoscopy is used in fish species to qualitatively assess morphological health and to visually identify the sex and maturity status of study fish accurately. Laparoscopy can begin in two different ways (two different insertion points). First, the procedure could be done by cutting a small incision in the fish's body cavity and inserting an endoscope to view gonads or other internal organs (Hernandez-Divers *et al*. 2004; Moccia *et al*. 1984; Swenson *et al*. 2007; Wildhaber *et al*. 2005). The second possible insertion method is that the endoscope can also be inserted through the urogenital pore, which avoids having to make an incision (Ortenburger *et al*. 1996). For laparoscopy using an incision entry point, a trocar is sometimes used. The trocar acts to "guide" the endoscope into the fish through the incision, and protects the incision from further tear. Endoscopes may also 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). Finally, insufflation with a gas is used to provide the visual internal space needed for effective examination with the endoscope.

Up to 24 shortnose sturgeon from the Cooper River would be exposed to laparoscopy (via incision) annually for the duration of the permit. After immobilized with MS-222 (effects of anesthesia are analyzed in a separate section), animals would be positioned in lateral recumbency on a portable surgical table. Researchers would make a 5 mm incision in the ventral body wall slightly off midline at a level midway between the pectoral girdle and the cloaca. A 5 mm trocar would then be inserted through the incision and a 5 mm rigid endoscope would be inserted through the trocar. If necessary, the body cavity would be insufflated with ambient air by attaching a battery-powered air pump to an insufflation port on the trocar.

When compared to other methods, laparoscopy 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 laparoscopy technique, inserting the endoscope through the urogenital pore for sex determination is not as consistent as sex determination of endoscopy 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 laparoscopic 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. Orgenburter *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 a*l. 2004).

Expected Response to Laparoscopy. 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 laparoscopy technique by incision rather than urogenital pore, we expect to see less complications than are reported for inserting an endoscope through a urogenital pore. In addition, 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. Laparoscopy would not be conducted on small fish. In addition, we expect that a large majority of the shortnose sturgeon that undergo this procedure would not have fin infections.

Available information reports that laparoscopy is safe when carried out carefully. All of the project staff responsible for performing the laparoscopy under this action have routinely performed similar procedures on shortnose sturgeon without complication in other NMFS permitted activity (Permit 1505).

The procedures would increase the risk of complications associated with the added stress of the surgical procedures and the extended time under anesthesia. Because the sutures used to close the laparoscopy sites penetrate the body wall, they would also provide a route of possible infection. To combat this, as small an incision as possible would be used, which would minimize the amount of suture necessary and decrease the healing time. Finally, suture ties would be kept as short as possible and a sterilizing treatment would be applied to the sutures prior to recovering the animal from anesthesia. This treatment would help prevent fungal growth

on the sutures that could possibly infect the animal prior to healing of the incision wounds. We expect that the small incision and insertion of the laparoscope would have little probability of killing or producing sub-lethal effects as healing is rapid, although delayed complications are possible.

Therefore, laparoscopy as proposed is not likely to reduce the viability of the shortnose sturgeon population in South Carolina Rivers. By extension, laparoscopy 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.

Gonad Biopsy. In some cases during laparoscopy, the sex of the fish is not readily apparent, so biopsies of the gonadal material could be taken for a definite sex determination. If necessary to determine sex, gonad biopsy samples could be taken from the annual subset of 24 Cooper River fish undergoing laparoscopy each year. This would only happen if sex is unclear, so an undetermined portion of the 24 shortnose sturgeon that undergo laparoscopy could also be biopsied. A 5 mm sized sample (2-3g) would be removed from each fish and placed in buffered formalin for preservation. Upon completion of the biopsy, the body cavity and biopsy site would be visually assessed to ensure that there was no obvious hemorrhaged or herniated tissue requiring additional attention. The incision would be sutured with a single suture in a cruciate pattern using PDS suture material.

Gonad samples do not cause disruptive hemorrhaging of the sampled site because of the lack of blood vessels in the vicinity of the sampled site. Further, sturgeon seem to return to completely normal behavior within a day or 2 after surgery (Jefferies, *pers. comm*., 2005). Hernandez-Divers *et al.* (2004) conducted laparoscopic sex determinations, gonadal biopsies (5 mm sample taken) and various reproductive surgeries on hatchery-reared Gulf of Mexico sturgeon. The five male sturgeon that received gonadal biopsies survived the surgery and the authors concluded that the surgery was minimally invasive, safe and effective.

Because no formal studies of sublethal effects of gonadal biopsies on sturgeon exist we looked to similar studies for insight. Studies conducted by Ritchie (1965, 1970) evaluated the effects of gonadal biopsies on the survival and the survival and recapture rates of striped bass, respectively. Ritchie (1965) conducted biopsies on 20 wild fish (10 age 2 fish and 10 age 3 fish) while in the lab. The gonads were accessed through the urogenital pore and fish were not fed for the duration of the experiment to produce uniform stress and magnify any effects caused by the biopsies. Fish were also not anesthetized. All fish were sacrificed and received necropsies at the end of the experiment. At necropsy, 15% of the fish had unhealing gonad wounds (three fish), one of which was considered to be serious. Tests to determine the survival between the groups of fish were inconclusive. Ritchie (1970) conducted field tests of the effects of gonadal biopsy using the same procedures as in Ritchie (1965) on the survival of tagged striped bass. The author concluded that the biopsies did not alter the survival rate or the travel habits of the striped bass.

Expected Response to Biopsy. We believe that gonad biopsy would have a minimal impact on the shortnose sturgeon population in South Carolina rivers. Previous researchers have indicated that biopsy surgery is safe and effective and gonad samples do not have potential to cause disruptive hemorrhaging at the sample site. Studies conducted on other fish species reveal

that survival rate after biopsy is either not altered, or has a very low incidence of chronic unhealed wound sites.

Therefore, biopsy as proposed is not likely to reduce the viability of the shortnose sturgeon population in South Carolina Rivers. By extension, biopsy 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.

Internal Transmitter Implantation. Annually, a maximum of 20 adult or juvenile shortnose sturgeon would be fitted for internal implantation of sonic transmitters tags. Four types of internal VEMCO tags could potentially be utilized, which would be chosen depending on the size/weight of each fish so that the weight of the transmitter does not exceed 2% of the body weight. These receiver specifications can be found in Table 3. Fish would be tracked passively with receivers positioned in the river to document movement within the river.

In general, adverse effects of these proposed tagging procedures could include pain, handling discomfort, hemorrhage at the site of incision, risk of infection from surgery, affected swimming ability, and/or abandonment of spawning runs. Choice of surgical procedure, fish size, morphology, behavior and environmental conditions can affect the success of telemetry transmitter implantation in fish (Jepsen *et al*. 2002).

Survival rates after implanting transmitters in shortnose sturgeon are high. Collins *et al*. (2002) evaluated four methods of radio transmitter attachment on shortnose sturgeon. They found 100% survival and retention over their study period for ventral implantation of a transmitter with internally-coiled antenna. Their necropsies indicated there were no effects on internal organs. Dr. Collins in South Carolina (M. Collins, *pers. comm., November 2006*) has also more recently reported no mortality due to surgical implantation of internal transmitters. DeVries (2006) reported movements of 8 male and 4 female (≥ 768 mm TL) shortnose sturgeon internally radiotagged between November 14 2004 and January 14 2005 in the Altamaha River. Eleven of these fish were relocated a total 115 times. Nine of these fish were tracked until the end of 2005. The remaining individuals were censored after movement was not detected, or they were not relocated, after a period of 4 months. Periodic checks for an additional 2 months also showed no movement. Although there were no known mortalities directly attributable to the implantation procedure; the status of the 3 unrelocated individuals was unknown (Devries 2006).

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

Tag weight relative to fish body weight is an important factor in determining the effects of a tag (Jepsen *et al*. 2002). The two factors directly affecting a tagged fish are tag weight in water

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

Implanted transmitters could affect fish swimming performance. Thorstad *et al*. (2000) studied the effects of telemetry transmitters on swimming performance of adult farmed Atlantic salmon. These researchers found that swimming performance and blood physiology of adult Atlantic salmon (1021-2338 g, total body length 45-59 cm) were not affected when equipped with external or implanted telemetry transmitters compared with untagged controls. There was no difference in endurance among untagged salmon, salmon with small external transmitters, large external transmitters and small body-implanted transmitters at any swimming speed. Authors cautioned that results of wild versus farmed salmon may be different (Peake *et al*. 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 affect fish growth. Juvenile Chinook salmon with transmitters in their stomachs (gastrically implanted) consistently grew more slowly than fish with surgically implanted transmitters, fish with surgery but no implanted transmitter, or fish exposed only to handling (Adams *et al*. 1998).

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

Since implantation requires surgery, healing has been described in available information. Several factors can affect obstacles to wound healing in fish including secondary infection and inflammation. Fish epidermal cells at all levels are capable of mitotic division, and during wound healing there is a loss of the intracellular attachments and cells migrate rapidly to cover the defect and provide some waterproof integrity (Wildgoose 2000). This leads to a reduction in the thickness of the surrounding epidermis and produces a thin layer of epidermis at least one cell thick over the wound, however the process can be inhibited by infection (Wildgoose 2000). Thorstad *et al*. (2000) state that incisions were not fully-healed in 13 of the farmed Atlantic salmon with implanted transmitters; two of these had signs of inflammation. Juvenile

largemouth bass implanted with microradio transmitters exhibited short-term (5 days) inflammation around the incision and suture insertion points for both non-absorbable braided silk and non-absorbable polypropylene monofilament, but in the longer term (20 days) almost all sutures were shed and the incisions were completely healed (Cooke *et al*. 2003). Chapman and Park (2005) examined suture healing following a gonad biopsy of Gulf of Mexico sturgeon and found both the absorbable and nonabsorbable sutures to effectively sew the skin after biopsy with all sturgeons surviving surgery and incisions healing 30 days after the intervention. Dummy radio transmitters compounded the inflammatory effect silk sutures had on healing incisions compared with inflammation without transmitters (Wagner *et al*. 2000).

The expulsion or rejection of surgically implanted transmitters has been reported from a number of studies, and has been mentioned as an argument for using externally attached transmitters. It does not appear that expulsion causes further complications or death in fish that manifest this occurrence. Such expulsions often occur shortly after tagging and can lead to premature end of studies. Rates of tag shedding and ways of implant exits depend on species, fish condition, tag weight and environmental conditions (Jepsen *et al*. 2002). There are basically three ways of implant exit; through the incision, through an intact part of the body wall and through the intestine. Trans-intestinal expulsion is rare but has been occasionally reported in rainbow trout (Chisholm and Hubert 1985). Five months after tagging 20% of juvenile Atlantic salmon had expelled their tags through the body wall, adjacent to the healed incision (Moore *et al*. 1990). No mortality or infection occurred as a result of tag expulsion, and fish continued to mature and behave like the control fish. Expulsion occurred in 13 of 22 rainbow trout tagged with dummy tags coated with paraffin wax within 42-175 days after tagging (Chisholm and Hubert 1985). In another study of rainbow trout, three of 21 fish expelled their tags via body wall without subsequent mortality (Lucas 1989). Tag expulsion by juvenile Atlantic salmon during their study occurred but was not a cause of death (Lacroix *et al*. 2004). Two surgically implanted transmitters were also apparently expelled by Atlantic sturgeon (Moser and Ross 1995). In Kieffer and Kynard's (1993) study, one shortnose sturgeon implanted with a sonic tag rejected its internal tag.

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

Expected Response to Internal Transmitter Implantation. We expect that shortnose sturgeon exposed to internal sonic transmitter implantation would respond similar to the available information presented above. Survival rates are expected to be high with no ill effects on internal organs expected as a result of the transmitters. We do not expect mortality to occur as a result of this procedure, although a few tagged fish from studies reported above have disappeared and their fate was unknown. We expect that growth rates or swimming performance could be affected and that expulsion of the transmitter could occur. Although, there have been

no mortalities or infections reported to be associated with expulsion. We expect that the surgical wound would heal normally, but acknowledge that adverse effects of these proposed tagging procedures could include pain, handling discomfort, hemorrhage at the site of incision, risk of infection from surgery, affected swimming ability, and/or abandonment of spawning runs. The research methodologies will minimize these risks, as choice of surgical procedure, fish size, morphology, behavior and environmental conditions can affect the success of telemetry transmitter implantation in fish (Jepsen *et al*. 2002).

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

Collection of ELS. Fifty sturgeon eggs/ELS would be collected and preserved each year from both the Savannah River and Lake Marion (and its tributaries) during the spawning runs of sturgeon with the objective of confirming the timing and scope of spawning activity. Each adult female 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 0.05% of the eggs produced in that year from the Savannah River and 0.05% of the eggs produced in that year from the Lake Marion population. As such, the annual proposed take of 50/94,000 eggs or larvae from the Savannah River and Lake Marion could have minimal effects on the shortnose sturgeon populations in South Carolina.

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 collection of ELS would likely result in more timely and conclusive data pertaining to sturgeon spawning in South Carolina.

Expected Response due to Collection of ELS. We do not expect the collection of up to 50 shortnose sturgeon ELS annually from the Savannah River and 50 shortnose sturgeon ELS annually from Lake Marion and its tributaries to document spawning activity 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), 50 eggs would be a minimal 0.05% of her total production. Therefore, the ELS collection methodology as proposed is not likely to reduce the viability of the shortnose sturgeon populations in South Carolina. By extension, the collection of 50/94,000 ELS per year from the Savannah River and 50/94,000 ELS per year from Lake Marion

and its tributaries 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.

Blood Sample. Blood would be collected from the caudal vein of 24 sturgeon each year. This is achieved by inserting a properly-sized (see Table 12) hypodermic needle, attached to a syringe, perpendicular to the ventral midline at a point immediately caudal to the anal fin. The needle is slowly advanced while applying gentle negative pressure to the syringe until blood freely flows into the syringe. Once the blood is collected, direct pressure is applied to the site of venipuncture to ensure clotting and prevent subsequent blood loss (Stoskopf 1993).

Table 12. Needle and syringe sizes proposed based on fish weight.

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

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

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

Therefore, blood sampling as proposed is not likely to reduce the viability of the shortnose sturgeon population in South Carolina Rivers. 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.

VIII. Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

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

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

IX. Integration and Synthesis of Effects

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

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

The proposed issuance by PR1 of scientific research Permit No. 15677 to Bill Post, South Carolina Department of Natural Resources, for research on shortnose sturgeon, would authorize directed take of shortnose sturgeon in South Carolina rivers (Savannah River, Ashepoo, Combabee and Edisto Rivers (including the Ashepoo-Combabee-Edisto (ACE) Basin), Cooper

River, Santee River, Lake Marion and its tributaries, and the Winyah Bay system, including the Black, Waccamaw, Sampit, Little Pee Dee and Great Pee Dee Rivers). The proposed activities under this permit include capture, handling, PIT and dart tagging, genetic tissue sampling, biopsy, blood sampling, anesthesia, internal attachment of sonic transmitters, and laparoscopy. The Status of the species 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, incidental capture in coastal fisheries, possible poaching, water pollution, decreased water quality (low DO, salinity alterations), land use practices, and impingement on intake screens of power plant operations. Reasonably likely future actions described in the Cumulative Effects section include state legislation to address current and future water supply and water quality concerns; riparian and coastal development; ecosystem, natural resource, and endangered species recovery and protection; soil conservation; and regulation of fisheries and invasive species.

The only available shortnose sturgeon density estimate for any of the South Carolina rivers included in the proposed action is for the Savannah River where the population is estimated to be 1,000 - 3,000 fish (Table 9).

Permit 15677 would be valid for five years from the date of issuance and would authorize non-lethal sampling methods on up to 154 shortnose sturgeon annually in South Carolina. Each fish would be captured, handled, weighed, measured, PIT and dart tagged, genetic tissue sampled, allowed to recover, and released. Additionally, a subset of fish from those captured would be anesthetized and either surgically implanted with a transmitter, or would undergo laparoscopy.

Although some degree of stress or pain is likely for individual fish captured, handled and tagged, and while tagging and tissue sampling will result in tissue injuries, none of the research procedures are expected to result in mortality or reduced fitness of individuals. Delayed or aborted spawning for some individual fish is a possibility, but the likelihood is remote given the minimization measures proposed. The proposed permit is not expected to affect these population's reproduction, distribution, or numbers. Because the proposed action is not likely to reduce the these population's likelihood of surviving and recovering in the wild, it is not likely to reduce the species' likelihood of surviving and recovering in the wild.

IX. Conclusion

After reviewing the current status of endangered shortnose sturgeon, the environmental baseline for the action area, the effects of the proposed research program, and the cumulative effects, it is NMFS's biological opinion that the issuance of this permit to Bill Post, South Carolina Department of Natural Resources, for research on shortnose sturgeon, is not likely to jeopardize the continued existence of the endangered shortnose sturgeon. Critical habitat has not been designated for shortnose sturgeon.

CONSERVATION RECOMMENDATIONS

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

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

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

REINITIATION NOTICE

This concludes formal consultation on the proposed permit 15677 to Bill Post, South Carolina Department of Natural Resources, for research on shortnose sturgeon in South Carolina, 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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