National Marine Fisheries Service
Endangered Species Act Section 7
Biological and Conference Opinion

Title:	Biological and Conference Opinion on Proposed Implementation of Program for the Issuance of Permits for Atlantic and Shortnose Sturgeon Research and Enhancement Activities Pursuant to Section 10(a) of the ESA
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Action Agencies:	Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
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NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL AND CONFERENCE OPINION

Title: Biological and Conference Opinion on the Proposed Implementation of a Program for the Issuance of Permits for Research and Enhancement Activities on Atlantic and Shortnose Sturgeon Pursuant to Section 10(a) of the Endangered Species Act

Action Agency: Permits and Conservation Division of the Office of Protected Resources, National Marine Fisheries Service

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service

Approved: Donna S. Wieting

Donna S. Wieting
Director, Office of Protected Resources

Date: MAR 20 2017

Consultation Tracking Number: FPR-2016-9176

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1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that any actions they authorize, fund or carry out are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with the National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 C.F.R. §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS, the USFWS, or both concur with that determination, consultation concludes informally (50 CFR §402.14(b)).

The Federal action agency shall confer with the NMFS for species under NMFS jurisdiction on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 CFR §402.10). If requested by the Federal agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in §402.14.

Section 7(b)(3) of the ESA requires that at the conclusion of consultation (or conference) NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species (or species proposed for listing) or destroy or adversely modify their designated (or proposed) critical habitat. If NMFS determines that the action is likely to jeopardize ESA-listed species or destroy or adversely modify critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

The action agency for this consultation is NMFS, Office of Protected Resources (OPR), Permits and Conservation Division (hereafter referred to as the Permits Division). The Permits Division proposes to implement a program for the issuance of permits for research and enhancement activities on Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*Acipenser brevirostrum*) within their United States (U.S.) east coast range from Maine to Florida, international Canadian waters, and including captive populations.

Consultation in accordance with section 7(a)(2) of the statute (16 U.S.C 1536 (a)(2)), associated implementing regulations (50 C.F.R. §402), and agency policy and guidance (USFWS and NMFS 1998) was conducted by the NMFS OPR ESA Interagency Cooperation Division (hereafter referred to as the Interagency Cooperation Division). This biological and conference opinion (opinion) and ITS were prepared by the Interagency Cooperation Division in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR §402.

This document represents NMFS's opinion on the effects of these actions on endangered and threatened species and designated critical habitat for those species. A complete record of this consultation is on file at the NMFS OPR in Silver Spring, Maryland.

1.1 Background

The ESA mandates the protection and conservation of threatened and endangered species, and prohibits the taking[1], import, and export of these species, with limited exceptions for scientific research and enhancement of propagation or survival, pursuant to ESA section 10(a)(1)(A) and its implementing regulations (50 CFR §222).

The Permits Division issues 10(a)(1)(A) permits authorizing activities that result in either directed take or incidental take of other ESA-listed species (i.e. not the targeted research species). At present there are 17 existing Section 10(a)(1)(A) scientific research permits issued for shortnose and Atlantic sturgeon. Each permit authorizes sampling of adult through juvenile life stages of sturgeon, and some permits have authorization to collect early life stages (early life stages) of sturgeon. All but four of these permits are set to expire in 2017. Many of these researchers have applied for a new 10(a)(1)(A) permit in 2017 in order to continue their sturgeon research programs. Considering the large workload that individual permits, including the ESA Section 7(a)(2) consultations, require, and the redundancy in terms of the types of research activities and their effects on listed species, the Permits Division has proposed to implement a new sturgeon research and enhancement permitting program (hereafter referred to as the Program). As part of the new Program, the Permits Division will evaluate and issue all sturgeon permits at the same time each year (i.e., annual permit cycle). The Permits Division will also establish maximum mortality limits for each sturgeon population, using a calculation that is protective of listed species while allowing necessary research and enhancement activities to proceed. The mortality limits will be used to determine whether some or all of the authorized activities requested in permit applications can be safely authorized.

The Permits Division now requests a programmatic Section 7 consultation to ensure that the new Program, including the proposed maximum mortality limit approach, is and will remain not likely to jeopardize listed species or to destroy or adversely modify critical habitat. Evaluating all permits at the same time each year and having a programmatic consultation in place: 1) enhances species conservation and management by conducting a more holistic assessments of impacts and minimizes impacts to species from duplication of research effort, 2) reduces the Permits Division

[1] Take under the ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (§4(19)).

processing time for scientific research and enhancement permit applications, and 3) consolidates the NMFS Section 7 consultation workload to avoid delays in issuing permits.

1.2 Consultation History

This opinion is based on information obtained from (1) the NMFS Permits Division biological assessment (BA), and supporting documents, on the implementation of a permitting program for the issuance of permits for research activities on Atlantic sturgeon and shortnose sturgeon, (2) correspondence and discussions between the Permits Division and the Interagency Cooperation Division, and (3) the available scientific information for analyzing the effects of the proposed action on ESA-listed species. Our communication with the Permits Division regarding this consultation is summarized as follows:

- **April 28, 2016**: The Permits Division and the Interagency Cooperation Division finalize an internal NMFS document titled *Terms of Reference for ESA section 7 Programmatic Consultations on the Scientific Research and Enhancement Permitting Program.*
- **May 11, 2016 thru January 19, 2017**: Regularly scheduled (weekly or bi-weekly) pre-consultation meetings between the Permits Division and Interagency Cooperation Division.
- **September 30, 2016**: The Permits Division submits a sturgeon programmatic consultation initiation package (including the BA and supporting documents) to the Interagency Cooperation Division.
- **October 28, 2016**: The Interagency Cooperation Division responds in a memo to the Permits Division indicating that there is not sufficient information in their initiation package to initiate formal section 7 consultation. In particular, the Interagency Cooperation Division requests more information and clarification related to the proposed sturgeon maximum mortality limit.
- **December 16, 2016**: The Permits Division submits a revised BA.
- **December 21, 2016**: The Interagency Cooperation Division reviews the revised BA and provides the Permits Division with a list of additional questions/comments that need to be addressed before formal consultation can be initiated.
- **January 9, 2017**: The Permits Division submits a revised BA.
- **January 17, 2017**: The Interagency Cooperation Division reviews the revised BA and concludes that all of the questions/comments on the previous version have been sufficiently addressed by the Permits Division. The Interagency Cooperation Division requests clarification on one issue regarding new text added since previous version.
- **January 27, 2017:** The Interagency Cooperation Division officially accepts the initiation package and notifies the Permits Division in a memo titled "Initiation of formal consultation pursuant to section 7 of the ESA on a proposed sturgeon research and enhancement permitting program."

2 DESCRIPTION OF THE PROPOSED ACTION

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. The Permits Division has requested programmatic consultation on a Program for the issuance of research and enhancement permits for Atlantic and shortnose sturgeon. There is no sunset date on the proposed Program. The proposed Program combines elements from the existing approach for issuing sturgeon permits with elements that are completely new. Both the existing and the new features of the Program are identified and discussed in this section of the opinion, which is organized as follows: (1) overall process for issuing and managing directed take permits under section 10(a)(1)(A) of the ESA; (2) directed take permit terms and conditions applicable via regulation to all such permits; (3) proposed annual sturgeon permit cycle; (4) research activities that will be authorized as part of the proposed Program; (5) proposed approach for processing applications and authorizing take under the Program; (6) the Permits Division internal program review; (7) requirements for reporting on the Program to the Interagency Cooperation Division; (8) proposed adaptive management approach; (9) areas affected directly, or indirectly, by the proposed Program (i.e., "action area"); and (10) interrelated and interdependent actions that may be associated with the proposed action.

2.1 Overall Process for Issuing Sturgeon Directed Take Permits

As stated in their BA, the Permits Division's mission is to "protect and conserve marine mammals and threatened and endangered species by providing special exceptions for take, import, and export that maximize recovery value and minimize individual and cumulative impacts as directed under ESA section 10(a)(1)(A) and its regulations" (NMFS 2017). Permits issued pursuant to section 10(a)(1)(A) of the ESA must be for activities that are likely to further the conservation of the affected species with the ultimate goal of bringing the species to the point where listing under the ESA is no longer necessary. The overall process that the Permits Division follows for issuance of section 10(a)(1)(A) permits is shown in Figure 1.

Section 10(d) of the ESA and implementing regulations at 50 CFR 222 identify the following criteria specific to issuance or modification of research and enhancement permits:

- Whether the permit was applied for in good faith
- Whether the permit, if granted and exercised, will not operate to the disadvantage of such endangered species
- Whether the permit would be consistent with the purposes and policy set forth in section 2 of the ESA (i.e., providing a means to conserve endangered and threatened species' ecosystems and providing programs for the conservation of such species

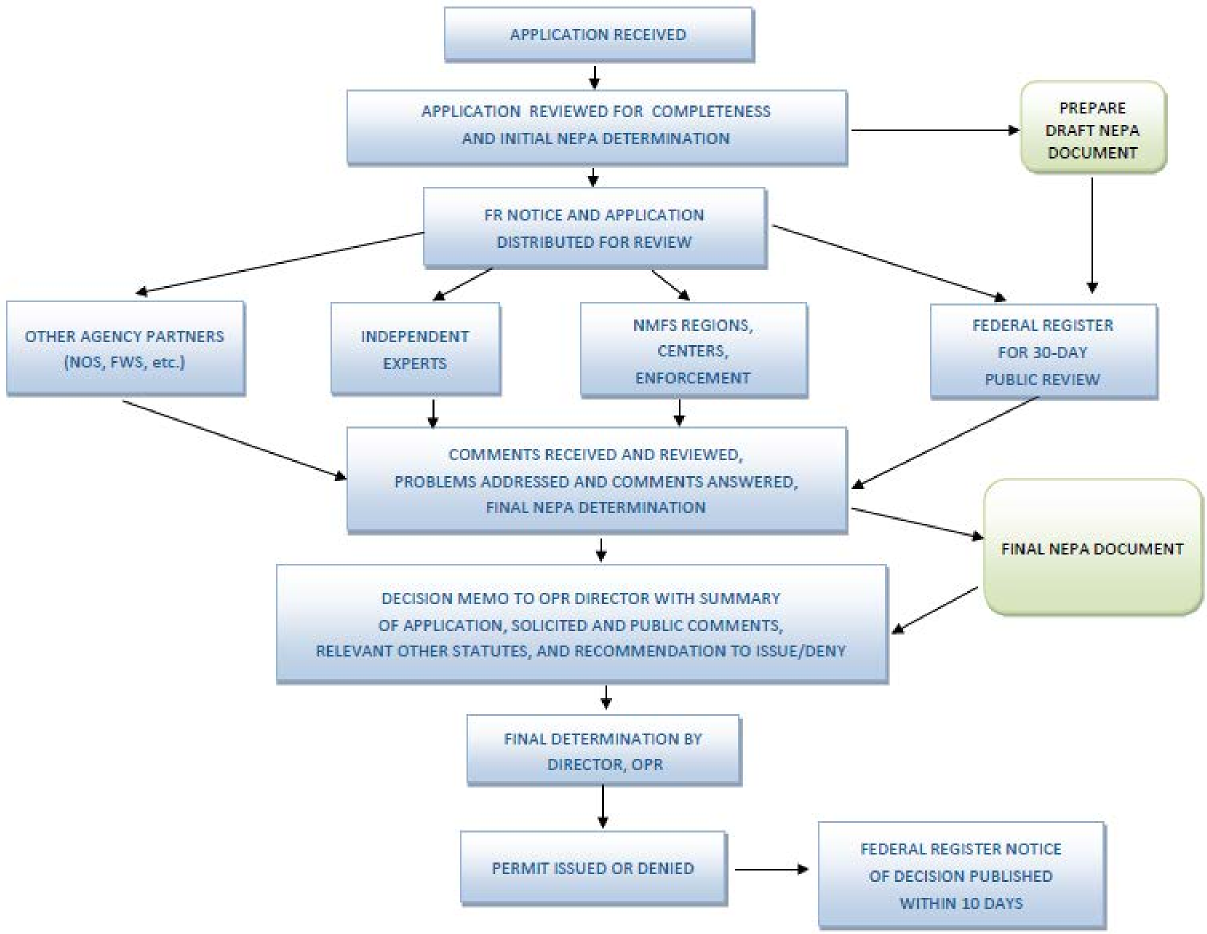

Figure 1. Flow chart of the overall process for issuing directed take permits under section 10(a)(1)(A) of the Endangered Species Act.

Applicants seeking a section 10(a)(1)(A) permit must submit an application to NMFS the Permits Division. The ESA and NMFS implementing regulations establish information requirements for permit applicants. The Permits Division's ESA section 10(a)(1)(A) application instructions for research and enhancement permits are provided in Appendix A. The applicant must provide sufficient information about the activity to allow NMFS to determine whether permit issuance would comply with all applicable statutory and regulatory issuance criteria and to assess the potential environmental impacts of permit issuance. Permit applications must include a discussion of how the proposed activities and resulting information will promote the conservation and recovery of ESA-listed species. More specifically, to complete their application researchers need to answer the following questions:

- How the action will enhance or benefit the wild population/species
- Whether the project has broader significance beyond the applicant's goals
- Why the work must take an endangered species

- How research is bona fide and likely to be published in a refereed scientific journal
- How the work will contribute to understanding the species' biology or ecology contribute to identified objectives of a species' recovery plan or otherwise respond to recommendations of a scientific body charged with management of the species, and contribute significantly to identifying, evaluating, or resolving conservation problems
- For enhancement, how the work will enhancing the health the survival, conservation, and recovery of the species in the wild, or will enhance the propagation of the species for conservation and recovery purposes
- How the research is not unnecessarily duplicative of other work
- The anticipated effects of the activities to protected species
- How the applicant will minimize impacts of the activities, in particular mortality
- How the applicant will coordinate activities with other Permit Holders

Applicants are encouraged to link research objectives to priorities identified in NMFS ESA-listed species recovery plans. Applications that satisfy some but not all of the applicable criteria for permit issuance are returned to the applicant with an explanation of the deficiencies. Applicants then have 60 days to provide the deficient information to the Permits Division. The permit process cannot proceed further until the Permits Division has the necessary information to complete the application.

Once a complete application has been received, the Permits Division reviews to determine all listed species that may be affected (directly or indirectly) by the research or enhancement activities and the nature of the effects. If the Permits Division determines the action may affect but is not likely to adversely affect listed species or designated critical habitat, the Permits Division submits a memorandum to the Interagency Cooperation Division with the description of action and rationale for the determination and requests concurrence pursuant to 50 CFR 402.13. If the Interagency Cooperation Division concurs, then ESA Section 7(a)(2) consultation is completed. For ESA Section 10(a)(1)(A)permit applications that include activities that result in "take," formal consultation must include a biological opinion issued by the Interagency Cooperation Division.

The Permits Division sends permit applications out for scientific review and publishes a Notice of Receipt in the Federal Register (FR) to begin a mandatory 30-day public review and comment period. NMFS may extend the comment period and hold public hearings on the application if deemed necessary. The Permits Division distributes research permit applications to several reviewers, who may include the NMFS Office of Law Enforcement, state agencies, and appropriate NMFS scientists and other federal agencies. After the close of the public comment period, the Permits Division reviews all comments received from reviewers and the public, and all substantive comments are addressed by either the Permits Division or the applicant. The

Permits Division then re-evaluates the issuance criteria for each permit in consideration of comments received and responses from the applicant, and makes a final recommendation to the OPR Office Director on whether to issue or deny the permit. The Permits Division will use a checklist (Appendix B) to document whether an application does or does not meet ESA issuance criteria and the other requirements discussed above.

If the permit is issued, a FR Notice of Issuance is published within 10 days, and the permit holder must date and sign the permit and return a copy of the signature page to the Permits Division as proof of their acceptance of the permit terms and conditions (50 CFR 222.303). If the permit is denied, the OPR Office Director must provide the applicant with an explanation for the denial (50 CFR 222.303). The applicant or any party opposed to a permit may seek judicial review of the terms and conditions of such permit or of a decision to deny such permit. Review may be obtained by filing a petition for review with the appropriate U.S. District Court as provided for by law (50 CFR 222.303).

2.2 General Permit Terms and Conditions

As stated in the Permits Division’s ESA permit template (Appendix C), activities authorized in a permit must occur by the means, in the areas, and for the purposes set forth in the permit application, and are limited by the terms and conditions in a permit. Permit noncompliance constitutes a violation and is grounds for permit modification, suspension, or revocation, and for enforcement action. A description of the general terms and conditions common to permits issued by the Permits Division for all species is provided here. Additional terms and conditions specific to permits issued under the Program are described in the sections to follow.

All research and enhancement permits contain terms and conditions that address the following:

- Duration of permit
- Number and kinds of protected species, locations and manner of taking
- Qualifications, responsibilities, and designation of personnel
- Possession of permit
- Reports
- Notification and coordination
- Observers and inspections
- Permit modification, suspension, and revocation
- Penalties and permit sanctions
- Acceptance of permit

Duration of Permits (50 CFR 222.304)

Each permit specifies an expiration date. Historically the Permits Division has issued ESA permits for up to five years, although the ESA does not limit the duration of a permit. As part of the proposed Program the Permits Division is opting to issue ESA permits for up to 10 years to reduce burdens on repeat applicants and streamline paperwork. A permit may be extended if the applicant has submitted a new application for work of a continuing nature (50 CFR 222.304). A Permit Holder operating under an extension may continue such activities as were authorized by the permit until a decision has been made on the renewal application. To ensure that environmental analyses prepared for issuance of the permit under the ESA and NEPA remain valid in extending the permit, the Permits Division conditions the extension such that no additional take of species is authorized over the life of the extension. Rather, the extension allows the Permit Holder to continue take of ESA-listed species authorized in the last year of the permit over an additional 12 months or until the Permit Holder has reached the take limit in the last year of the permit. The permit also clarifies that the Permit Holder may continue to possess biological samples of the target species acquired under the permit after permit expiration without additional written authorization.

Number and Kinds of Protected Species, Locations and Manner of Taking (50 CFR 216.36, 222.301(e), and 222.308(d))

Each permit contains a table outlining the number of animals authorized to be taken (by species and listing unit), and the locations, manner, and time frame in which they may be taken. In addition, authorized personnel working under a permit may take photographs and video incidental to research or enhancement provided it does not result in take not authorized by the permit.

Qualifications, Responsibilities, and Designation of Personnel (50 CFR 216.3, 216.35(f-i), 216.36, and 216.41(c)(iii) and (iv))

All research and enhancement permits identify by name the researchers (Principal Investigator [PI] and Co-investigators [CIs]) authorized to direct and supervise the permitted activities. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities. The roles and responsibilities of personnel operating under a permit are as follows:

- The Permit Holder is ultimately responsible for activities of individuals operating under the permit. Where the Permit Holder is an institution, the Responsible Party is the person at the institution who is responsible for the supervision of the PI.
- The PI is the individual primarily responsible for the taking, import, export, and related activities conducted under the permit. The PI must be on site during activities conducted under this permit unless a CI is present to act in place of the PI.
- CIs are individuals who are qualified to conduct activities authorized by the permit without the onsite supervision of the PI. CIs assume the role and responsibility of the PI in the PI’s absence.

- Research Assistants work under the direct and on site supervision of the PI or CI. They cannot conduct permitted activities in the absence of the PI or CI and are not named in the permit.

Personnel involved in permitted activities must be reasonable in number and essential to the conduct of the permitted activities. Essential personnel are limited to the following:

- Individuals who perform a function directly supportive of and necessary to the permitted activity (including operation of vessels or aircraft)
- Individuals included as backup for essential personnel, and
- Individuals included for training purposes

Persons who require state or Federal licenses to conduct activities authorized under a permit (e.g., veterinarians, pilots) must be duly licensed when undertaking such activities. Permitted activities may be conducted on vessels or aircraft or in cooperation with individuals engaged in commercial activities, provided the commercial activities are not conducted simultaneously with the permitted activities, except with written approval of the Permits Division Chief, such as for a news article or documentary film. The Permit Holder cannot require direct or indirect compensation from persons requesting to conduct activities under the permit. For permits held by NMFS offices, the Permits Division may allow the Responsible Party or PI to designate additional CIs and must provide a copy of the letter designating the individual to the Permits Division on the day of designation.

For sturgeon research permit applications, as part of the proposed action the Permits Division will carefully review researcher qualifications for research activities that have an associated risk of mortality of wild sturgeon including capture methods, anesthesia, gastric lavage, and surgical placement of internal tags. The Permits Division will require applicants to demonstrate their qualification for performing inherently riskier procedures by including details such as: (1) a signed certification from the trainer or PI indicating that the proposed individual can perform the activities safely while unsupervised and has the ability to supervise and train others, (2) details describing how many times the proposed individual has performed the procedure successfully and on what species/age classes, (3) when the experience in performing the procedure was attained, (4) any relevant publication history, and (5) an Institutional Animal Care and Use Committee approval, if available.

Possession of Permit (50 CFR 216.35(i) and (j), 222.301(d)(1) and (2), 222.305), and 222.308(d))

Permits cannot be transferred or assigned to any other person. The Permit Holder and persons operating under the authority of a permit must possess a copy of the permit when engaged in a permitted activity. A copy of the permit must be attached to any means of containment in which a protected species or protected species part is placed for purposes of storage, transit, supervision or care.

Reports (50 CFR 216.38, 216.41(c)(ii), 222.301(h) and (i), and 222.308(d))

Permit Holders must submit annual and incident reports, and papers or publications resulting from the activities authorized by a permit. Research results must be published or otherwise made available to the scientific community in a reasonable period of time. Annual reports must be submitted at the conclusion of each year for which a permit is valid, due 30 days after the end of each reporting period (either a calendar year or a 12-month period). The Permits Division will then have 30 days to review the reports and, if needed, request additional information from permit holders. The Permits Division will send reminders to any permit holder who has not sent in their report. After an additional 30-day grace period, if the report is not received the permit may be suspended until it is received and approved by the Permits Division. The Permits Division may take additional measures to ensure that reports are received in a timely manner including: (1) Deferring or returning modification requests for an active permit until the report is received, (2) Deferring or returning an application for a new permit until the report is received, and (3) Notifying the NMFS Office of Law Enforcement of a permit violation due to failure to report.

As required by conditions of the permit, each annual report must include the following:

- A table reporting the number of animals taken, by activity and location
- Observed effects and frequency of effects from permitted activities for target and non-target animals
- Problems or unforeseen effects encountered and steps to resolve such problems
- Discussion of any serious injuries, mortalities, or unauthorized species taken
- Efforts to conduct post-research monitoring
- Efforts to coordinate and collaborate with other Permit Holders and NMFS Regional Offices
- Progress to meeting the objectives, including citations of reports, publications resulting from the reporting period
- Additional information as required by the permit on a case-by-case basis to monitor impacts of specific activities to animal health, effectiveness of protocols, etc.

Appendix D includes the Permits Division’s annual report form, which has been recently revised to improve the Permits Division’s monitoring capabilities and inform other section 7 consultations. On a case-by-case basis, the Permits Division may determine that a permit also requires additional reporting to closely monitor and evaluate the impacts of specific research procedures. This may occur when more information is needed on the potential for harm or injury of a research procedure or when new scientific information (reports, publications, presentations, etc.) indicates that an activity may warrant closer monitoring for impacts to the target species or other portions of the environment. When such a report is required, the permit also will contain a requirement for annual reauthorization. In this scenario, the permit is temporarily suspended at the end of each permit year (12-month period) and the Permit Holder must report on the work that occurred during the year as noted above and any additional monitoring requirements, such as re-sighting data, photographs or tag transmissions of target animals, for the Permits Division's review. Based on review of the report, veterinarian and expert opinions as warranted, and relevant information from the literature, the Permits Division may modify, discontinue or reauthorize the activities under the permit for the next permit year.

Incident reports are required for any events of serious injury or exceeding take authorized by the permit. Incident reports must be submitted within two weeks of the incident and describe the events and steps that will be taken to reduce the potential for additional incidents. If the activity is not authorized or the Permit Holder reaches their mortality take limit, as required by the permit, researchers must immediately cease permitted activities until the Permits Division allows the work to resume. The Permits Division reviews the report and facts relevant to the incident, such as a necropsy report for mortality, and determines whether the methods and protocols and/or permit requirements, such as mitigation measures or take numbers, need to be modified before work can resume.

After the conclusion of research or permit expiration, the last annual report due for the permit must include the above details for annual reports in addition to:

- Whether the objectives were met and what was learned;
- An explanation of why objectives were not accomplished, if applicable;
- A description of how the activities benefited the species, promoted recovery, or conserved the target species and fulfilled objectives listed in the recovery or conservation plan; and
- Identification of any additional or improved mitigation measures.

This information is merged into the annual report form for the last year that a report is due to streamline reporting, resulting in a combined annual/final report.

Notification and Coordination

Permit Holders must provide written notification of planned fieldwork to the applicable NMFS Assistant Regional Administrator at least two weeks prior to initiation of a field trip/season and must include the locations of the intended field study and/or survey routes, estimated dates of research, and number and roles of participants. Permit Holders must coordinate activities with 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, repeated disturbance of animals.

Observers and Inspections (50 CFR 216.36, 222.301(g), (i) and (j), and 222.308(d))

At the request of NMFS, the Permit Holder must allow an employee of NMFS or another designated other person to observe permitted activities. The Permit Holder must provide documents or other information relating to the permitted activities upon request.

Modification, Suspension, and Revocation (50 CFR 216.36, 216.39, 216.40, and 222.306; 15 CFR Part 904 Subpart D)

Permits are subject to suspension, revocation, modification, and denial in accordance with the provisions of subpart D of 15 CFR part 904. The OPR Office Director may modify, suspend, or revoke a permit in whole or in part under the following circumstances:

- To make the permit consistent with a change in the regulations prescribed under section 103 of the Marine Mammal Protection Act (MMPA) or section 4 of the ESA
- In a case in which a violation of the terms and conditions of the permit is found
- In response to a written request from the Permit Holder
- If NMFS determines that the application or other information pertaining to the permitted activities includes false information
- If NMFS determines that the authorized activities will operate to the disadvantage of threatened or endangered species or are otherwise no longer consistent with the purposes and policy in section 2 of the ESA

Permit Holders may also request modifications. Because ESA regulations do not distinguish between types of modifications, the Permits Division adopts MMPA regulations defining major and minor amendments (50 CFR 216.39) for issuance of ESA and joint ESA/MMPA permits. As such, a “major” modification to an ESA permit is a request to change any of the following:

- The number or type of species to be taken/imported/exported
- The location where animals are taken/imported/exported
- The manner in which animals are taken/imported/exported such that it would result in an increased level of take or risk of adverse impact
- Increase the duration for more than 12 months

Public comment periods are required for major modifications. Minor modifications (e.g., modifying tag designs that result in equivalent or lesser impacts) and authorization letters (e.g., adding co-investigators) do not require public comment periods. Issuance of a permit does not guarantee or imply that NMFS will issue or approve subsequent permits or modifications for the same or similar activities including those of a continuing nature, requested by a Permit Holder.

Penalties and Permit Sanctions (50 CFR 216.36, 216.40(a), 222.301(f), and 222.306(e)

A person who violates a provision of a permit, the MMPA, ESA, or the regulations at 50 CFR 216 and 50 CFR 222-226 is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the MMPA, ESA, and 15 CFR part 904. In addition, per ESA regulation, permits shall not be altered, erased, or mutilated, and any permit which has been altered, erased, or mutilated shall immediately become invalid. OPR is the sole arbiter of whether a given activity is within the scope and bounds of the authorization granted in a permit. The Permit Holder must contact the Permits Division for verification before conducting an activity if they are unsure whether an activity is within the scope of the permit. Failure to verify, where the Permits Division subsequently determines that an activity was outside the scope of the permit, may be used as evidence of a violation of the permit, the MMPA, the ESA, and applicable regulations in any enforcement actions.

Acceptance of Permit (50 CFR 216.33(e)(3)(i) and (ii))

When a permit is issued by signature of the OPR Office Director, the Permit Holder must date and sign the permit, and return a copy of the original signature to the Permits Division. The permit is effective upon the Permit Holder's signing of the permit. In signing an ESA permit, the Permit Holder

- Agrees to abide by all terms and conditions set forth in the permit, all restrictions and relevant regulations under 50 CFR Parts 222-226, and all restrictions and requirements under the ESA
- Acknowledges that the authority to conduct certain activities specified in the permit is conditional and subject to authorization by the Office Director
- Acknowledges that the permit does not relieve the Permit Holder of the responsibility to obtain any other permits, or comply with other Federal, State, local, or international laws or regulations

2.3 Annual Permit Cycle

To date, the Permits Division has processed individual sturgeon research permit requests as they are received, batching the processing of requests that have a similar nature and scope where possible. However, issuing permits on a case-by-case basis provides less opportunity for authorizing and monitoring annual take of ESA-listed species than does a holistic. To address this, the Permits Division is proposing to test the implementation of an annual permit cycle for the Program. The Permits Division will establish a trial annual permit cycle for processing new sturgeon permit applications and major modifications. All of the permit issuance requirements identified above will still apply. Minor permit modifications and authorizations, often administrative in nature, that do not increase the risk of adverse impacts to the species and can often be processed within a few weeks, will continue to be processed throughout the year as they are received.

The Permits Division will set an application deadline for all sturgeon researchers each year. The Permits Division will have six months to (1) review and process all sturgeon research permit requests for the upcoming year, (2) conduct an evaluation of the level of requested take for all permits requested for each species, life stage, and river population, and (3) issue permits authorizing research activities and take, as appropriate, following the detailed procedures described herein as part of the proposed action. If a permit request is received after the submission deadline, at the Permits Division Deputy Division Chief's discretion, the request may either be merged into the batch or the applicant will have to wait until the next permit cycle for the request to be processed. This decision will largely be based on the completeness and complexity of the request.

In the past, consultations between the Permits Division and the Interagency Cooperation Division for sturgeon research permits were conducted either on individual section 10 (a)(1)(A) permits or on several similar permits combined (i.e., "batched consultation"). Under the proposed Program, the Permits Division will be responsible for ensuring that submitted permit applications that fall within the scope of this programmatic biological opinion are processed in accordance with the requirements of the opinion.

2.4 Sturgeon Research Activities and Associated Mitigation Measures

The following is a description of the general activities that may be authorized by the Permits Division as part of the proposed Program. All sampling and handling of sturgeon will be conducted following the guidelines established in "A Protocol for the Use of Shortnose and Atlantic Sturgeon" (Moser et al. 2000), and as further amended by NMFS in "A Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons" (Kahn and Mohead 2010). The Permits Division will require mitigation measures to minimize impacts to protected species when authorizing sturgeon research activities. Permit Holders will be required as a condition of their permits to adhere to all mitigation measures discussed below and described in more detail in Appendix C.

2.4.1 Capture and Collection Methods

Sturgeon researchers use a variety of sampling methods and techniques for capturing sturgeon, depending upon the targeted life stage and mitigations prescribed to avoid capturing non-target species. Sampling location (e.g., river, offshore coastal waters) and bottom type (e.g., mud, sand, and rocks) may also play a role in the gear and/or method selected for capture. Not all capture methods discussed here will be authorized in each individual permit. Permit holders will need to specify their proposed capture method(s) and demonstrate their understanding of the required mitigation measures associated with each method proposed.

Gill Nets: Gill nets are a commonly used gear for conducting research on adult and juvenile sturgeon. Two main types of gill nets will be authorized for use as part of the proposed action: anchored gill nets and drift gill nets. Anchored gillnets are attached to poles fixed in the substrate or an anchor system to prevent movement of the net. Drift gillnets are kept afloat at the proper depth using a system of weights and buoys attached to the headrope, footrope, or floatline. Atlantic and shortnose sturgeon will be captured with anchored gill net sets fishing off the bottom (usually about 1.8m up from the substrate) and in a variety of depths (but a general range would be from 10-60 feet deep). Gill net mesh sizes will vary depending on the size of fish targeted but will typically range from 10 to 18-cm stretched mesh size. Drift gill nets will be set on the bottom perpendicular to the prevailing flow and allowed to move with the flow for a short period of time (generally between 30 minutes and two hours), depending on the tides and currents present. To insure the safety of the sturgeon captured in gill nets, researchers will adhere to established mitigation measures regarding environmental conditions, net set duration times and dissolved oxygen (DO) concentration levels during sampling (Kahn and Mohead 2010) (Table 1). The Permits Division will use Table 1 as a guideline to establish permit conditions for sturgeon capture in gill nets, and other types of gear as discussed below. Presently, environmental conditions for permitted research will occur between 0-30°C, 4.0-4.5mg/L (or at least 55 percent saturation) and net set durations will be between 0.5-14 hours. Based on the best available scientific information, the Permits Division may opt to change these environmental conditions and net set durations in the future (either making them more or less restrictive), as long as such changes do not increase the anticipated adverse effects on sturgeon or other ESA-listed species.

Gill nets would be attended during daylight hours to avoid marine mammal and sea turtle interactions where documented, and in waters having minimum DO concentrations of 4.5 mg/L. Netting would typically cease above 28°C water temperature. However, a controlled netting protocol would be authorized where soak times would be reduced to 30 minutes at water temperatures between 28 and 30°C and/or DO concentrations between 4.0 and 4.5 mg/L, subject to additional reporting requirements for documenting and avoiding harmful stress to animals. Water quality conditions for drift nets will be similar to that conditioned for anchored gillnets. Drift net sets will be continuously tended due to the risk of gear entanglement or loss of gear resulting in ghost nets, and fishing gear will be pulled immediately if a sturgeon or non-target ESA-listed species were captured.

Trammel Nets: Trammel nets used for fish capture typically consist of 2-4”mesh sizes for the inner panes, and 8-12” in the outer panels, although experimental trammel nets will vary depending on the targeted animal. Netting material consists of heavy multifilament nylon mesh. Trammel nets will be anchored on the bottom and fished in water depths comparable to gill nets. Therefore, the same standardized netting protocols (duration, temperature, and DO) as described above for gill nets will be followed for trammel nets fished on the bottom.

Trawls: Small trawls have proven effective for collecting multiple life stages of sturgeon in a variety of habitats of sand and mud bottoms, and flat stretches free of debris (Dovel 1983). Small skiff trawls (5.1 or 8-cm mesh, 10m headrope) will be used in the main stem and mouths of rivers. Skiff trawls used for sturgeon research may be towed at a maximum speed of 2.5 knots and up to 20 minutes per trawl (bottom time) in marine water areas and up to ten minutes in fresh water areas. The use of small trawling gear will be subject to the same netting environmental conditions with respect to temperature and DO as described above for gillnets. Smaller epibenthic trawls, referred to as "Missouri trawls," used for the capture of young-of-year and juvenile sturgeon will also be authorized (Phelps et al. 2010; Savoy and Benway 2004). Larger otter trawls, typically used in offshore environments on sandy bottoms, will also be authorized for sturgeon capture. Otter trawls have a longer headrope than the skiff trawls (25 m), larger mesh sizes (8 or 12-cm) and are equipped with heavy steel doors, which require the gear to be mechanically hauled. Due to the environmental conditions where they will be used, tow speeds for otter trawls will likely be faster than for small skiff trawls. Tow speeds authorized will be determined by the conditions encountered but the maximum tow speed allowed for otter trawls will be 3.5 knots.

Table 1. Summary of environmental conditions regulating the duration of net sets to capture Atlantic and shortnose sturgeon.

Water Temperature (ºC)	Minimum DO Level (mg/L)[a]	Minimum D.O Level (percent saturation)[a]	Maximum Net Set Duration (hours)
0 ≤ 15	4.5	55 percent	14.0[b]
15 ≤ 20	4.5	55 percent	4.0[c]
20 ≤ 25	4.5	55 percent	2.0[c]
25 ≤ 28	4.5	55 percent	1.0[c]
28 ≥ 30	4.0-4.5	55 percent	0.5[c,d]
≥ 30	N.A.	55 percent	Cease netting

a) Either minimum DO (mg/L) or percent saturation (i.e., 55 percent) levels must be met for each net set duration.
b) Net-set duration of 14 hours (including unattended, overnight) is limited to fresh water (< 2.0 parts per thousand) ranges where unidentified populations or life stages may exist for presence or absence study objectives.
c) Net sets must be continuously monitored and checked upon a net strike by targeted or non-targeted catch.
d) Exceptions to netting in water temperature between 28 ºC to 30 ºC and in DO concentrations between 4.0 to 4.5 mg/l is authorized only by coordinating with the Permits Division prior to the scheduled sampling takes place. No more than 10 days of such sampling can be authorized during any annual period on any river system. Animals captured in this environment must be active and completely recovered in an onboard aerated tank before releasing it.

Trotlines: Trotlines are a passive method of sampling, consisting of multiple baited hooks that are attached to a long fishing line that is held stationary in the current by anchors at both ends. While commercial fishing operations have incidentally captured Atlantic or shortnose sturgeon with trotlines, this gear has not yet been used for research on these species (Collins and Smith 1998). However, trotlines have been used by researchers studying other sturgeon species, and those studies will initially be relied upon to established research sampling protocols for Atlantic and shortnose sturgeon (Elliot and Beamesderfer 1990; Steffensen et al. 2013). All trotline sampling as part of the proposed Program must conform to the USFWS Biological Procedures and Protocols for Researchers and Managers Handling Pallid Sturgeon (USFWS 2008) and/or other protocols as established by the Permits Division. Gear specifications include main line length (64.5 meter long 6.25 mm-rope), hook size/type (2/0, 3/0, 4/0, 5/0, 6/0, 7/0, and 8/0 circle hooks), dropper length (1.5 m away from anchor attachment points), hook/leader spacing (40 hooks every 1.5 m), and bait (night crawlers, sand worms or cut bait (Killgore et al. 2007; Phelps et al. 2009; Steffensen et al. 2013). Water temperature and DO levels established for anchored gill nets will be followed when deploying trotlines. Trotlines will be positioned parallel to the flow for a minimum duration of one hour before retrieval, but no longer than four hours total to alleviate any potential stress to fish from longer hook times. To minimize capture and handling stress, the proposed action will condition permits so that researchers must monitor trotline deployment closely with minimal time intervals between running lines. Additionally, because there is little information available on predation of sturgeon while caught on trotlines, NMFS will condition permits to avoid using trotlines in marine waters where predators might be present.

Traps: The proposed action will authorize the use of pound, fyke and other trap nets for the capture of sturgeon. Rather than actively capturing or gilling fish, pound or trapping gear spans the depth of the water column and diverts fish away from shore and into the trap located offshore. Pound nets or trapping gear may be used for sturgeon research in freshwater areas (<3.0 parts per thousand [ppt]) where sea turtles or marine mammals are not anticipated. Where applicable, these gear types will only be fished in water temperatures below 15°C between December and April. The maximum duration such gear could be fished without checking will be 14 hours. Sturgeon researchers may use trapping gear as a temporary fish holding pen for up to two hours.

Beach Seines: The use of beach seines will be authorized as part of the proposed action for targeting young-of-year or juvenile sturgeon. Beach seines work by creating a wide arc that encircles fish in shallow water and draws them in toward the beach. The headrope of the seine (~30 meters long) is fitted with floats on the surface and the footrope remains in permanent contact with the bottom weighted leaded line. Sturgeon research sampling protocols for beach seine use include the following: (1) when drawing a beach seine's lead line close to shore, animals must not be crowded, and clear waters with minimal turbidity or mud bottoms must be maintained when fish are gathered, (2) all animals will be handled and released within 15 minutes after pooled along the shore, (3) bycatch will be minimally handled and released unharmed, (4) areas sampled will not be seined more than once in a 24-hour period, and (5) areas sampled will be characterized by sandy, flat bottoms free of organic matter, debris or bottom snags. .

Egg Mats, D-Nets, and Epibenthic Sleds: As part of the proposed action, egg mats, D-nets, and epibenthic sleds may be deployed downstream of suspected spawning areas to collect floating sturgeon eggs and larvae. Egg mats are circular, polyester floor-buffing pads anchored to the bottom that can passively collect eggs adrift at the spawning site. No more egg mats may be fished than necessary, and they must be checked at least twice per week. D-nets are bottom-anchored drift nets that are 5 m long, with a D-shaped mouth (76 cm wide by 54 cm high), and fitted with a knotless mesh designed to capture 3 to 4-mm diameter eggs, free embryos, and larvae. D-nets may be set for a maximum duration of three-hour intervals before checking. A modified version of a D-net is known as an epibenthic sled, equipped with a flow meter and towed to collect eggs or other early life stages. Egg mats and D-nets may be fished at temperatures relevant to when spawning is anticipated by researchers, roughly corresponding to ranges of 10 ºC to 25 ºC in the spring and 18 ºC to 25 ºC in the fall.

New or Improved Capture Methods: While the above capture methods and protocols are those commonly used for sturgeon research to date, additional capture methods, or improvements to existing methods, may become available as methods/protocols evolve with technological advances. This could include improvements such as in mesh size, net size or net material, or completely new net/trap designs that allow for capture or collection in areas or at times that currently are not logistically feasible. As part of the proposed action, the Permits Division may authorize additional new capture methods or variations of the gear described above as they become available. As applicable, the Permits Division's standard mitigation measures would apply to any new gear authorizations. In addition, any detrimental impacts (i.e., serious injury or mortality) to the species considered in this biological opinion resulting from new or modified capture methods will not exceed the impacts and take levels evaluated and authorized as part of this opinion, otherwise reinitiation of this consultation will be required.

2.4.2 Research Procedures on Captured Sturgeon

As part of the proposed action, permitted researchers will perform various procedures on Atlantic and shortnose sturgeon. Standard protocols for performing these procedures while minimizing the adverse effects on individual fish are described below.

2.4.2.1 Procedures not Expected to Result in Delayed Mortality After Release

Holding: After capture Atlantic and shortnose sturgeon may be held in a floating net pen or on-board the research vessel in a live well. Once they have recovered from the stress of capture, sturgeon may be transferred to a secondary processing station (e.g., a sling) onboard for weighing, measuring, and further processing. To minimize stress and preserve the fish's slime coat, researchers would wear latex gloves when handling sturgeon. When held in on-board tanks, sturgeon will be immersed in a continuous stream of water supplied by a pump-hose assembly mounted over the side of the vessel. In some situations, DO will be supplemented with compressed oxygen to ensure DO concentration does not fall below acceptable levels. The total time required to complete routine handling and tagging will be approximately one minute. Sturgeon undergoing other, more involved procedures will be returned to the net pen or live well until all other sturgeon are processed. The maximum amount of time an individual sturgeon will be held after removal from capture gear is two hours. The exception to this is for sturgeon that are held in specialized pound nets (e.g., in Chesapeake Bay). A specialized pound net is an expanded enclosure on all four sides, open to the surface, and utilized as a holding pen for extended holding periods. The Permits Division may authorize researchers to hold sturgeon for up to 24 hours in such enclosures, assuming the fish are unstressed and the water quality is good.

Measuring and weighing: Researchers typically use either a spring scale or a platform scale to weigh sturgeon. Sturgeon weighed on a spring scale will be supported using a sling or net. Sturgeon weighed on a platform scale will be placed on a small waterproof cushion attached to the surface of the weighing platform. Morphometric measurements including total length (TL), fork length (FL), and interorbital width (for confirmation of species identification) will be taken using a measuring board, solid ruler, or calipers, as appropriate.

Transport: Sturgeon research permit holders will be authorized to transport animals, parts or tissues to other quarantined locations where short-term collaborative research is contemplated. The Permit Holder must contact the Permits Division prior to transport to insure the recipient and facility meet requirements for such research, and is listed as a Co-investigator. Typically, only captive sturgeon are expected to be transported between facilities. If wild-caught sturgeon are transported to facilities to meet proposed research objectives, they will be released at the site of capture within 12 hours, unless lethal take has been authorized. Guidelines for transporting sturgeon include the following:

- Fish transport and handling equipment (e.g., tanks, dip nets, buckets, measuring boards, scales, etc.) must be sanitized and neutralized prior to and after use.
- DO concentration in hauling water must be maintained optimally during transport (typically between 7 and 12 mg/L) using dual or redundant oxygen support systems (e.g. primary compressed oxygen system with backup mechanical aerators).
- The ratio of fish mass to water volume during transport should not exceed 0.75 pounds per gallon.
- The duration of transport should not exceed 48 hours.
- While under transport, the condition of fish must be checked at least at hourly intervals, measuring DO, temperature, condition and activity of fish, and system efficiency.
- Water used for live sturgeon transport should be similar to the source water, and should be maintained at ≤ 20°C during transit, if possible.
- During transport of live sturgeon, salt (0.1 to 0.3 percent), or other osmoregulator (i.e., “slime coat”) is recommended to be added to transport water to minimize osmoregulatory stress.

- Sturgeon arriving at the new holding facility must be acclimated to the receiving water (2°C change/15 minutes) and observed for signs of stress for at least one hour prior to leaving them unattended.
- When animals are transported to another facility, the Permit Holder must quarantine the animals separately upon arrival, treating them prophylactically with approved methods, while also preventing the escape of any life stage.
- Transport of fertilized embryo, fry and younger life stages of sturgeon is authorized in iced sealed bags necessary to regulate water quality, temperature and DO levels for up to 48 hours.

Hydroacoustics/Sonar: Sonar can produce high quality images of fishes in dark or turbid water from echoes created as the fish pass through the beam. Due to their distinct body shape, sturgeon can be distinguished from other fishes using this technology (Brundage and Jung 2009). This imaging technique offers unique advantages as it allows researchers the opportunity to study sturgeon without capture.

Photograph/Videography: Photography and videography will be allowed during permitted research to document the health of the fish, research methods, and any identifying marks on sturgeon that may be useful for future identification. Researchers are authorized to use photography/videography as along as it does not interfere with other research activities.

Ultrasound: Ultrasound is one of the safest and least invasive methods for sturgeon sexual identification (Kahn and Mohead 2010). Sturgeon are placed in a prone position in a holding tank with the ventral surface exposed to air. The ultrasound transducer is coated with ultrasound gel. During scanning, output power, focus depth, and frame rates are kept constant. The transducer is maneuvered along the abdomen between the gills and the anus.

Tissue sampling: In order to characterize the genetic make-up and level of diversity of Atlantic and shortnose sturgeon within a population, a small sample (1 cm^2) of soft fin tissue will be collected from the trailing margin of a fin using a pair of sharp sterilized scissors. Tissue samples will be preserved in individually labeled vials containing 95 percent ethanol. As a condition of their permit, sturgeon researchers will provide genetic tissue samples to either the U.S. Geological Survey (USGS) Facility in Leetown, West Virginia or to another facility identified by NMFS as a tissue repository.

PIT tagging: Passive integrated transponder (PIT) tags will be used to identify captured fish. PIT tags are internal and act as a lifetime barcode for an individual animal. They are dormant until activated by an electromagnetic field generated by a close-range scanning device (Smyth and Nebel 2013). As a requirement of the permit, all untagged fish (≥ 300mm TL) will be tagged with a PIT tag injected under the skin on the left side of the body, immediately anterior to the dorsal fin and posterior to the dorsal scutes with a hypodermic needle and syringe. The primary position that PIT tags can be injected is in the anterior dorsal fin musculature. However, in smaller sturgeon, to ensure tag retention and prevent harm or mortality, the PIT tag may also be inserted at the widest dorsal position. Individual researchers can use other proven methods, such as under the fourth dorsal scute; however, the researcher would be required to inform all other researchers of such tagging position to ensure detection of all tags. Researchers may use PIT tags measuring 11.5 mm length x 2.1 mm diameter in juvenile sturgeon measuring at least 350 mm TL. The most commonly used size of PIT tag for sturgeon larger than 350mm is 12.5 mm. Alternately, PIT tags measuring 8.4 mm x 1.4 mm diameter may be used in sturgeon measuring between 250 and 350 mm TL. As technology advances and smaller tags are made, researchers will be allowed to utilize those tags to meet research objectives as long as the impact is equal to or less than the impact analyzed for this programmatic.

External identifier tags (Floy t-bar, dart, anchor): Permit holders will be authorized to attach floy, dart, and T-bar external tags to track Atlantic and shortnose sturgeon movement and behavior. These types of external tags will be inserted with an injecting needle at the dorsal fin base in the musculature just forward and slightly downward (from the left side to the right) locking into the dorsal pterygiophores of the dorsal fin. After removing the injecting needle, the tags would be spun between the fingers and gently tugged to lock in place. T-bar tags will not be authorized for sturgeon <300 mm TL.

Telemetry tagging (external): External acoustic telemetry tags will also be authorized for tracking sturgeon movement and behavior. External telemetry tags range in size from 18-46mm long and 7-9mm in diameter, and are typically less than 2 percent of the fish’s body weight. External telemetry tags will be attached to Atlantic and shortnose sturgeon using the procedure outlined in Kahn and Mohead (2010). Over time, the leader attaching the external tag to the fish corrodes, freeing the tag from the fish.

Satellite tags: Pop-up Satellite Archival Tags (PSATs) are archival tags that will be authorized for use by sturgeon researchers. PSATs are more sophisticated than traditional telemetry tags because, in addition to recording location data of tagged animals, they can also record temperature and depth data, allowing a more comprehensive understanding of the environment the fish occupies. To track movements and habitat use PSATs are designed to be neutrally buoyant in marine environments. Similar to external telemetry tags, PSATs can be attached externally without surgery by fastening the tag to the dorsal fin with heavy monofilament line (Erickson et al. 2011). Another method for PSAT attachment with monofilament involves drilling holes through two scutes and inserting silicone tubing (~ 10 cm long coated in Neosporin).

Gill biopsy: Researchers will either biopsy the outer portion of the gill (not the inner portion where blood flow is greatest) or scrape the gill filaments, depending on the particular research objectives. Gill biopsy samples will be 2 mm in size.

Blood collection: Sturgeon blood is collected for several purposes including detection of endocrine disruption (e.g., presence of estrogenic compounds), sex determination, and stress hormone levels. Blood will be collected from the caudal veins by inserting a hypodermic needle perpendicular to the ventral midline at a point immediately caudal to the anal fin. The needle will be slowly advanced while applying gentle negative pressure until blood freely flows into the syringe. Immediately after blood is drawn, direct pressure will be applied to the wound to ensure clotting and prevent further blood loss (Stoskopf 1993). Blood volume and needle size will vary depending on fish weight. For fish weighing more than 200 g up to 6 ml of blood will be taken using a 20g x 1" (gauge x length) needle. For fish weighing between 100-200g up to 3 ml of blood will be taken using a 22g x 5/8" needle. For fish weighing between less than 100g up to 2 ml of blood will be taken using a 22g x 5/8" needle.

Borescopy: Borescopy is an invasive procedure used to determine the sex and maturity of sturgeon (Moser et al. 2000). A probe (7" long x 0.16" wide) is inserted through the sturgeon's genital opening and into the genital tract (Kynard and Kieffer 2002). During the procedure the fish's head and most of the body remain anesthetized under water. The entire procedure, including standard handling and measuring, typically takes less than four minutes.

Laparoscopy: Laparoscopic examinations are used in fisheries research to determine sex and reproductive status, and this procedure has been refined for sturgeon work (Hernandez-Divers et al. 2004). Using sterile techniques and equipment, a small (~4 mm) incision is made in the ventral body wall slightly off midline, midway between the pectoral and pelvic girdle through which a trocar would be inserted. A rigid laparoscope (typically 5mm in diameter) would then be inserted through the trocar to allow visualization of gonads. 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 to increase the working space within the body cavity. Air pressure in the body cavity is released naturally. In those instances where the sex of the fish is not readily apparent, a gonad biopsy will be taken (see below). The incision will be closed with a single suture in a cruciate pattern using suture material and sterilized with iodine or a similar disinfectant or antibiotic. Due to the increased risk of this procedure, laparoscopy will only be performed in a laboratory setting.

Gonad biopsy: If the sturgeon's sex cannot be determined from laparoscopy, a gonad biopsy will be taken for histological evaluation and sex determination. A second small (~5 mm) incision will be made midway between the first incision and the pectoral girdle on the lateral aspect of the body approximately one cm dorsal to the ventral scutes. A second 5mm trocar will then be inserted through the new incision, followed by a laparoscopic biopsy instrument to biopsy the gonad material. The sample will approximately 5-mm in size (2 to 3-g) and will be placed in a solution (e.g., 10 percent neutral, buffered formalin) for preservation. Upon completion of the biopsy, the body cavity and biopsy site will be visually assessed to ensure that there is no obvious tissue hemorrhaging or herniation. The laparoscope and the two trocars will then be removed from the body, the incisions will be closed with a single suture in a cruciate pattern using suture material, and the wound will be sterilized with iodine or a similar disinfectant or antibiotic. Due to the increased risk of this procedure, gonad biopsies will only be performed in a laboratory setting. The exception to this is if the researcher is also implanting an internal acoustic tag, in which case the gonad biopsy can be performed in the field (Kahn and Mohead 2010).

Fin ray sampling: Fin ray sections display a distinct banding pattern that can be used to determine a sturgeon's age. An earlier approach to fin ray sampling practiced by some sturgeon researchers involved removal of the entire fin ray (Collins and Smith 1996; Parsons et al. 2003). However, newer approaches have been developed that proved as effective but less deleterious compared to entire ray removal. As such, for the proposed action the Permits Division will no longer authorize the removal of the entire fin ray. Instead, the Permits Division will authorize the following fin ray sampling procedures: (1) removal of a small segment (1 cm^2) of the first fin ray, or (2) sampling the second marginal fin ray. Fin ray sampling will be done using sterilized surgical instruments and training will be required for anyone authorized to conduct these procedures. To minimize any adverse effects of the first procedure, fish will be placed under anesthesia prior to surgery. Baremore and Rosati (2014) and Ruddle (2016) found that sampling the second marginal fin ray on sturgeon was an effective aging technique that did not require anesthesia. Both studies found that removal of the second fin ray was less invasive, faster (1-minute) and easier to perform in the field, and did not require anesthesia to make the excision. The second marginal fin ray will be isolated from the fin spine and neighboring fin rays using a scalpel, by making an incision of approximately 1 cm in length on either side of the fin ray, about 1 cm from the pectoral fin origin. A pair of fine-point nail clippers will then be used to cut through each end of the 1-cm segment and remove the fin ray from the fin. When possible, fin rays will be removed from both the left and right sides of each individual in order to determine whether there is consistency between age estimates from both sides.

Scute/apical hook sampling: Another technique that can be used for age determination and chemical reconstruction of natal life histories involves sampling of sturgeon scute spines (Altenritter et al. 2015). The fish is anesthetized and then positioned on a firm surface and held down fore and aft by a field assistant. The most prominently ridged dorsal scute in the set anterior of the dorsal fin is selected for sampling. A fine-toothed manual saw is used to cut a wedge shaped sample of scute material with two oblique cuts perpendicular to the long-axis of the scute spine (i.e., across the back). One cut starts at the anterior (leading) edge of the scute spine and angles posteriorly, and the other starts at the posterior edge of the spine and angles forward to meet the first cut. This procedure takes 10-20 seconds and results in collection of a roughly 0.5-1.5 cubic centimeter piece of material, depending on the size of the fish. This sampling technique will be carried out on adult, subadult, and juvenile sturgeon as part of the proposed action.

Anesthesia: Certain procedures (e.g., internal tagging and laparoscopy) authorized as part of the proposed action will require anesthetization. Anesthetization will not be authorized for less invasive procedures and will only be authorized by the Permits Division for procedures where it is needed to minimize potential adverse effects that may occur in the absence of anesthesia. Noticeably stressed sturgeon (i.e., loss of equilibrium, hemorrhaging) will not be anesthetized, nor will they subject to any invasive procedures. Two primary means of anesthetization will be used to anesthetize captured sturgeon: chemical anesthesia (tricaine methanesulfonate or MS-222) and physical anesthesia (electronarcosis or galvanonarcosis).

Chemical Anesthesia: Sturgeon will be placed in a water bath solution containing buffered MS-222 for anesthetization (Summerfelt et al. 1990). Researchers will use the prescribed MS-222 doses described in (Kahn and Mohead 2010). MS-222 concentrations of up to 150 mg/L will be used to sedate sturgeon to a proper state of anesthesia depending on the procedures being performed. If proven safe and effective, the Permits Division may authorize other chemical anesthetics as long as the impact on sturgeon is equal to or less than the impact of MS-222. After the anesthesia is administered, sturgeon will be continuously monitored for signs of proper sedation by squeezing the tail to gauge the fish's movement and equilibrium, and checking for steady opercula movement. The time required for anesthetization and recovery will vary depending on the prevailing water temperature and quality (Coyle et al. 2004; Matsche 2011). Just prior to performing the procedures, sturgeon would be removed from the anesthetic bath to a moist surgery rack. Respiration will be maintained by pumping fresh ambient water across the sturgeon's gills with a tube inserted in the fish's mouth. After the procedure, sturgeon will be allowed to recover to normal swimming behavior in boat-side net pens or holding tanks.

Physical Anesthesia: In addition to chemical anesthetization discussed above, physical sedation via electronarcosis (also known as electroanesthesia or galvanonarcosis) may be authorized. When conducting physical anesthetization on sturgeon in freshwater (< 3 ppt salinity) researchers will use non-pulsed direct current voltage (0.3-0.5 V/cm, 0.01 A) to immobilize fish during surgery (Balazik et al. 2013; Henyey et al. 2002; Matsche 2011). In this procedure, fish will be placed in a tank with an anode screen at one end and a cathode screen at the other end. As voltage is applied quickly to the anode (1-2 sec), the subject fish will lose equilibrium, relax, and sink to the bottom. Voltage will then be decreased until the fish becomes immobilized but is still exhibiting strong opercula movement. Fish will be supported with a cradle so only their back or ventral surface are emerged from the water while the surgical procedure is performed.

2.4.2.2 Procedures with Some Risk of Delayed Mortality After Release

Surgical telemetry tagging (internal): Internal telemetry tags will be surgically implanted in sturgeon to track their movements. Captured fish will be anesthetized and held motionless on their backs (i.e., ventral side up) in a holding box with water covering the gills. Using sterile instruments, an incision will be made approximately 10 cm posterior to the pectoral girdle and just lateral of the midline. A surgical opening of 4 cm will then be made in the belly of the fish and an inert, sterilized sonic tag will be pushed posterior into the surgical opening. The incision will be closed either with a non-absorbable suture in a cruciate pattern or with a sterile resorptive suture material, and swabbed with iodine. The fish would then be allowed to recover (to equilibrium) upright in a flow-through water system before being released into the wild. The entire procedure for implanting internal transmitters generally takes from 3-5 minutes.

To minimize the inherent risk associated with this highly invasive procedure, the Permits Division has imposed the following restrictions on internal tagging of sturgeon:

- This procedure will only be conducted on fish that are in excellent condition (i.e., active, healthy weight).
- To minimize the risk of adverse effects on sturgeon this procedure will not be conducted when the water temperature exceeds 27°C (to reduce handling stress) or is less than 7°C (incisions do not heal as rapidly in low temperatures).
- This procedure will not be performed on sturgeon < 300 mm TL.
- The weight of the internal telemetry tag selected for implanting must be less than two percent of the fish's total weight (in air).

Sturgeon will be tracked either passively with an array of remote VR2W receivers (currently VEMCO is commonly used) positioned in the river or coastal waters or actively by technicians using mobile hydrophones from a research vessel. While there are several types of commercially available internal fish tags, many sturgeon researchers try to use telemetry technology that is compatible with other sturgeon researchers. This allows them to collaborate with researchers whose receivers may detect their previously tagged sturgeon that have migrated to the other researcher's study area.

Gastric lavage: Atlantic and shortnose sturgeon foraging habits can be studied by using gastric lavage to evacuate the stomach contents for analysis. Protocols for gastric lavage will follow those described in Kahn and Mohead (2010) based on methods tested and developed in previous sturgeon research studies (Collins et al. 2006b; Haley 1998; Murie and Parkyn 2000; Savoy and Benway 2004). To mitigate the potential adverse effects from gastric lavage, researchers will be required to address the known negative effects seen in other studies by following methodologies of successful researchers conducting lavage as described in Moser et al. (2000) and Kahn and Mohead (2010). These methods include using light anesthesia and using the right sized soft flexible tubing to avoid abrasion, rupturing the bladder or other injury when positioning the lavage tube. Adequate training in the procedure will be required prior to conducting gastric lavage on Atlantic or shortnose sturgeon. Additionally, no other invasive procedures will be conducted on fish that have undergone gastric lavage.

Sturgeon undergoing gastric lavage will be anesthetized to relax the alimentary canal prior to the procedure. A flexible polyethylene tube will be passed through the sturgeon's alimentary canal. The tube size (outside diameter) will vary depending on the size of the fish: 1.90 mm for fish from 250-350 mm TL; 4.06 mm for fish from 350-1,250 mm; and 10.15 mm for fish > 1,250 mm. Proper positioning of the tube in the stomach will be verified by feeling the tube from the fish's ventral surface. Stomach contents will be removed by gently flooding the stomach cavity with water delivered from a low-pressure hand pump. Food items dislodged from stomachs of sampled sturgeon will be collected with a sieve and preserved in 95 percent ethanol for later identification. Fish will be allowed to recover in a floating net pen alongside the boat prior to release into the wild. The entire procedure, including anesthetization, typically takes between seven to eleven minutes (Collins et al. 2006b). No other invasive procedures will be conducted on fish that have undergone gastric lavage.

2.4.2.3 New Sturgeon Research Procedures

As new technologies are developed and techniques improved, the Permits Division anticipates new research procedures may be proposed by sturgeon researchers. Additional risks may be associated with new or experimental procedures. The Permits Division will only authorize a new procedure (i.e., one that is not discussed above), if, after reviewing the best available scientific information, they determine that (1) the procedure is effective at achieving the research objectives, and (2) any adverse effects on sturgeon resulting from the procedure are less than or equal to the adverse effects of any of the procedures previously authorized or described above for the same research objectives.

2.4.3 Research Activities on Captive Sturgeon

Lethal and nonlethal research on captive Atlantic sturgeon and shortnose sturgeon that may be authorized as part of the proposed action include, but is not limited to, the following areas of investigation: physiology, disease, propagation techniques, anesthesiology, neurology, fish passage, fish behavior, technology (e.g., tagging); toxicology, genetics, contaminants, immunology, euthanasia, life history, water quality, nutrition and endocrinology. Researchers working with captive sturgeon must submit a proposed study plan to the Permits Division summarizing the study protocols and objectives. Research results will be documented in annual reports to the Permits Division and in final published journals articles. Captive sturgeon may be used as a source supply of additional research animals by collaborators listed in permits, as well as by other researchers or educational display facilities having their own permitted authority from NMFS. An annual inventory of surviving animals must be reported to the Permits Division annually. The number, condition, losses and the final disposition of all captive sturgeon, must be reported annually or periodically to the Permits Division, as requested. Incidence of unintentional harm or mortality should be reported initially to the Permits Division within two business days, followed by an official report of the incident within two weeks. Anticipated yearly numbers of captive sturgeon for research purposes should be communicated in writing to the

Permits Division approximately 180 days prior to propagating progeny through captive breeding. All research with captive sturgeon, including anticipated lethal research, must be consistent with standard husbandry care routinely occurring at such facilities in voluntary compliance with the Animal Welfare Act (7 U.S.C. 2131 et. seq.). Sturgeon must be fed and maintained properly, given daily care, treated humanely, and provided medical care as necessary. Upon intended or unintended lethal take of captive sturgeon, the Permit Holder should first preserve the animals on ice until discussing further disposal or research options with the Permits Division. Commercial aquaculture and the sale of live sturgeon (or sturgeon parts) are not authorized. When a captive sturgeon permit expires, upon consultation with the Permits Division, the permit holder may choose to apply to renew the permit, transfer the cultured sturgeon to another permitted facility, or euthanize and dispose of the animals using humane measures. Release of captive sturgeon to natural environments is not authorized under the NMFS permit unless the permit is amended under separate authority.

2.5 Authorizing Take Under the Sturgeon Research Permitting Program

Scientific research permits authorized under the Permits Division’s proposed Program will promote sturgeon conservation and recovery, and result in a net benefit to ESA-listed species and DPSs. As discussed above, as a condition of their permit, researchers will be required to follow specific protocols to avoid, minimize, and mitigate the unintended detrimental effects that may result from research activities such as capture, handling, or performing various invasive procedures. In addition to these standard protocols, as a condition of their permit researchers are required to consider additional precautionary measures to further minimize potential impacts on sturgeon. While these precautionary measures have proven highly effective at reducing detrimental impacts of research, and continue to improve over time, there remains some risk of sturgeon mortality, either (1) “in-hand” mortality as a direct result of capture, handling or performing a procedure, or (2) delayed mortality due to invasive procedures (e.g., surgery, gastric lavage) performed on captured fish. As such, some small amount of lethal take (i.e., mortality) will be authorized for research permitted under the Permits Division’s proposed Program. The Permits Division is responsible for ensuring that the cumulative impact of lethal and sublethal takes authorized will not approach a level that jeopardizes the continued existence of any sturgeon species or DPS.

Beyond ensuring the action is not likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat, the Permits Division will attempt to reduce the level of authorized sturgeon take to the maximum extent possible while also ensuring sturgeon researchers can collect valuable information necessary for species conservation and recovery. The Permits Division’s proposed approach for authorizing, monitoring, and managing lethal and sub-lethal take of sturgeon is described in this section.

2.5.1 Establishing Sturgeon Maximum Mortality Limits

The Permits Division proposes to establish maximum mortality limits for authorizing and managing lethal take of Atlantic and shortnose sturgeon. The level of lethal take authorized will be a function of the estimated population size and a calculated population health index. Conceptually, the maximum mortality limits represent a level of mortality that balances the objectives of promoting sturgeon research necessary for recovery and minimizing adverse effects. Mortality limits, as proposed, would be well below the maximum number of individuals that could be removed from a population while still allowing for species recovery. The maximum mortality limit would establish an upper limit on the average annual lethal take over any five-year period. The Permits Division has also proposed a maximum mortality limit buffer that is equal to the annual average mortality limit level, which could be used if the annual average is exceeded in any given year.

Maximum mortality limits will be created and monitored for each species (or DPS) at the spawning stock (or river system) level based on the underlying assumption that the continued existence of each individual spawning stock is vital to the continued existence of the species or DPS as a whole. Authorization of sturgeon mortality at the spawning stock level considers the importance of preserving the genetic diversity within each river system, and represents a conservative approach to protecting the species (or DPS) as a whole. This approach is consistent with that taken by NMFS for other ESA-listed species. For example, for many Pacific salmonids recovery criteria are established for individual populations determined to be "essential" to the recovery of the species (or Evolutionary Significant Unit, as listed) as a whole.

Within each spawning stock, separate maximum mortality limits will be established for juvenile and adult sturgeon (note: the adult maximum mortality limit will include mature adults and subadults). An early life stage maximum mortality limit will also be established for each spawning stock (discussed below in Section 2.5.3). Partitioning Atlantic and shortnose sturgeon into maximum mortality limits by fish size will allow the Permits Division to evaluate the impacts of mortality to the species based on an animal's reproductive potential (i.e., sexually mature fish that are able to contribute to the population vs. sexually immature fish with a higher rate of natural mortality and therefore lower contribution potential to the population size). Past research efforts targeting juvenile Atlantic sturgeon with small mesh nets in both northern and southern spawning rivers have captured one, two, and three year-old fish ranging up to 1,000 mm FL Bahr, 2016 #1}(Sweka et al. 2007). The Permits Division will establish a juvenile Atlantic sturgeon maximum mortality limit for the lethal take of fish smaller than 1,000 mm FL, exclusive of early life stages, which will be discussed below. Atlantic sturgeon ranging between 1,000 to 1,300 mm FL are sometimes referred to as "subadults" (Bain et al. 1999). For purposes of authorizing lethal take as part of the proposed Program, Atlantic sturgeon subadults will be combined with adults into a single maximum mortality limit for each river system. Although shortnose sturgeon growth rates vary by region and sex, all fish mature at between 450-550 mm

FL throughout the species' range (Dadswell et al. 1984; Peterson and Bednarski 2013). Shortnose sturgeon ranging between 450 to 600 mm FL sometimes referred to as "subadults," will be combined with adults (> 600 mm) for the adult/subadult maximum mortality limit. Thus, the following sturgeon maximum mortality limits will be established at the spawning river population level:

- *Atlantic sturgeon juvenile maximum mortality limit:* Juveniles < 1,000 mm FL (exclusive of early life stages)
- *Atlantic sturgeon adult/subadult maximum mortality limit:* Adults ≥ 1,300 mm FL & subadults 1,000-1,300 mm FL)
- *Shortnose sturgeon juvenile maximum mortality limit:* Juveniles < 450 mm FL (exclusive of early life stages)
- *Shortnose sturgeon adult/subadult maximum mortality limit:* Adults > 600 mm FL & subadults 450-600 mm FL

Based on the best information available, as part of the adaptive management approach to the proposed Program the Permits Division may adjust the size ranges defining the adult/subadult and juvenile maximum mortality limits for each species as new biological information is made available (e.g., size/age at reproductive maturity).

The sequence of seven steps for creating juvenile and adult/subadult sturgeon maximum mortality limits under the proposed Program is as follows:

1. Create sturgeon status matrices based on best available information for each species and river system (i.e., spawning stock).
2. Derive scores for each indicator in the status matrices based on the status score key.
3. Combine scores for recruitment indicators (i.e., adult survival, spawning frequency, juvenile presence, and juvenile threats) into an overall recruitment score for each river system.
4. Calculate an adult and juvenile (if juvenile population estimate available) health index for each river system based on a combination of the recruitment score (or trend score if available) and population score (census and/or effective). If no juvenile population estimate is available, the adult health index will be used for the juvenile maximum mortality limit as a conservative measure.
5. Use health index to categorize each river system into a health category, and determine the maximum proportion of the estimated population that can be authorized as mortality.
6. Create adult and juvenile maximum mortality limits for each river system.
7. Update status matrices on an annual basis. Repeat steps two through six (above) for any river system with new or updated information.

A schematic overview of the seven-step process for creating sturgeon maximum mortality limits under the proposed permitting Program is shown in Figure 2. Each step is described in more detail below.

Step One: Create Status Matrices

The Permits Division will compile the best available information regarding the status of individual adult and juvenile Atlantic and shortnose sturgeon spawning stocks for input into status matrices. Information for creating and updating status matrices will be obtained from multiple sources including species five-year status reviews, recovery plans, published journal articles, and annual reports submitted by permitted researchers. The Permits Division staff will use their best professional judgment in determining status matrix inputs based on their evaluation of the available scientific studies, and sturgeon experts (both within and outside of NMFS) will be consulted as needed to interpret study findings and validate matrix inputs. Status matrix inputs will include the following, as available, for each river system:

1. Estimated population trend: direction (positive, stable, negative), magnitude (percent change)
2. Estimated population size: empirical adult census population, effective population (based on genetic information), juvenile census population
3. Estimated adult survival rate (percent rate of survival)
4. Spawning frequency (regular, intermittent, unknown)
5. Presence of juvenile year-classes (i.e., age 0's, 1's, 2's, and 3's; up to 1,000 mm FL for Atlantic sturgeon and 450 mm FL for shortnose sturgeon) and their progression through year-classes
6. Juvenile threats: threat type (e.g., water quality, impingement/entrainment, bycatch, competition/predation/disease), and severity (major or minor)

Table 2 shows an example status matrix for the 10 individual spawning stocks (or river systems) that comprise the South Atlantic DPS of Atlantic sturgeon (Note: table inputs are shown for example only, and may not reflect the most current information available).

Step Two: Create Status Indicator Score Matrices

Information from the status matrices is converted into score matrices using the key shown in Table 3. Trend scores range from -4 to +4, with increasing (+4) and stable (+2) populations receiving positive trend scores and decreasing populations receiving negative trend scores. Adult census and effective population size scores range from -2 to +2 with population value ranges reflecting the relative differences among river systems based on the best available science. For river systems where an estimated juvenile census population size is available, the same key used for adult population census scores will be used to assign a juvenile census population score.

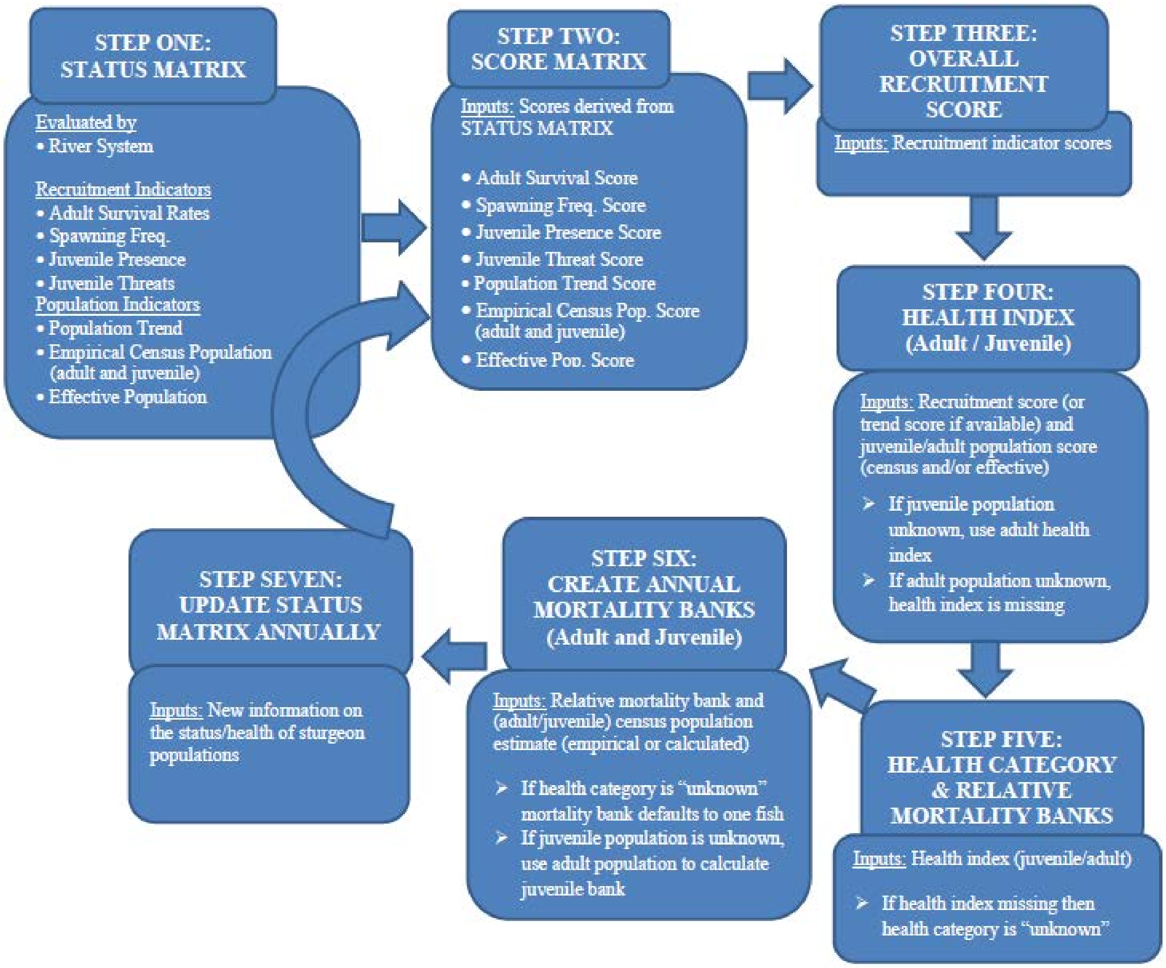

Figure 2. Schematic overview of the seven-step process for creating sturgeon maximum mortality limits under the proposed Program.

Adult survival scores range from -3 to +3, with survival rates of 83 percent and below receiving a negative score and rates above 86 percent receiving a positive score. Threat scores range from 0 to -4 (i.e., threats cannot be positive) depending on the number and severity of known threats. A "major" threat is one that if removed or significantly reduced could lead to the recovery of the river system population. A "minor" threat is one that likely results in a low level of mortality or reduced fitness (SSSRT 2010). Juvenile presence scores range from zero (no juveniles present) to +4 (juvenile progression through all age-classes). Spawning frequency scores also range from zero (no spawning) to +4 (regular spawning). An example of a status indicator score matrix for the ten river systems that comprise the South Atlantic DPS of Atlantic sturgeon is shown in Table 4.

Table 2. Example of an Atlantic sturgeon status indicator matrix for ten spawning stocks within the South Atlantic Distinct Population Segment. Empty cell indicates no available information.

Spawning Stock	Recruitment Indicators							Population Indicators		
	Adult Survival (%)	Spawning Frequency	Juveniles Presence	Juvenile Threats				Population Trend (%)	Empirical Census Pop. (mean) Adult/Juvenile	Effective Pop. (mean)
				Major Threats	Major #	Minor Threats	Minor #			
ACE Basin	87%	Regular			0	Water Quality, By-catch	2			41
Ashepoo					0		0			
Sampit					0		0			
Broad					0		0			
Savannah		Regular	Progression through age classes		0	Water Quality, By-catch, Impinge/Entrain	3			75
Ogeechee		Regular	Present		0	Water Quality, By-catch	2			56
Altamaha	84%	Regular	Progression through age classes		0	Water Quality, By-catch	2			133
Satilla		Regular			0	Water Quality	1			24
St. Mary's		Regular			0	Water Quality	1			
St. John's					0					

Table 3. Key used to convert sturgeon status matrix inputs into status indicator scores.

Population Indicators

Trend Score	Percent Change Adult Population Size
-4	≤ -5%
-2	> -5% to 0%
2	> 0% to 1%
4	> 1%

Emperical Census Population Score	Emperical Census Population Size (Adult or Juvenile)
-2	0-500
0	> 500 to 1500
2	> 1500

Effective Population Score (mean)	Effective Population Size
-2	≤ 40
0	> 40 to 70
2	> 70

Recruitment Indicators

Adult Survival Rate Score	Adult Survival Rate
-3	≤ 80%
-1	> 80% to ≤ 83%
0	> 83% to ≤ 86%
1	> 86% to ≤ 89%
3	< 89%

Threat Scores	Number of Major/Minor Threats
-4	2 or more major threats
-3	1 major threat
-2	2 or more minor threats
-1	1 minor threat
0	No known threats

Major threat - one that if altered could lead to recovery
Minor threat - one that likely results in a low level of mortality or reduced fitness

Juvenile Presence Score	Juvenile Presence
4	Juvenile progression through age classes
2	Juveniles present
0	No Juveniles present

Spawning Scores	Spawning Frequency
4	Regular spawning
2	Intermittent spawning
0	No spawning

Table 4. Example of a status indicator score matrix for the ten river systems that comprise the South Atlantic Distinct Population Segment of Atlantic sturgeon.

Spawning Stock	Recruitment Indicator Scores				Population Indicator Scores		
	Adult Survival Score	Spawning Frequency Score	Juvenile Presence Score	Juvenile Threat Score	Trend Score	Empirical Census Pop. Score (Adult / Juvenile)	Effective Pop. Score
ACE Basin	1	4		-2			-2
Ashepoo				0			
Sampit				0			
Broad				0			
Savannah		4	4	-2			2
Ogeechee		4	2	-2			0
Altamaha	0	4	4	-2			2
Satilla		4		-1			
St. Mary's		4		-1			
St. John's				0			

Step Three: Calculate Overall Recruitment Score Based on Recruitment Indicators

The next step is to combine the individual recruitment indicator scores (i.e., adult survival, spawning frequency, juvenile presence, and juvenile threats) into an overall recruitment score for each river system. The average of the spawning juvenile presence scores (both ranging from zero to +4) is added to the juvenile threat score which ranges from zero to -4. Thus, when combined as such the score for these three indicators ranges from -4 to +4. This combined score is then averaged with the adult survival score to arrive at the overall recruitment score. The adult survival score, although important, is given slightly less weight (ranges from -3 to +3) in this calculation since it represents only one out of the four indicators used to measure recruitment. The overall recruitment score formula is as follows:

$$\textit{Overall Recruitment Score} = \overline{[\textit{Adult Survival Score}, (\overline{(\textit{Spawining Score}, \textit{Juvenile Presence Score})} + \textit{Juvenile Threat Score})}$$

If some of the indicator scores in the equation above are unknown, the overall recruitment score can still be calculated with the remaining scores as long as (1) the spawning score <u>or</u> the juvenile presence score is known, <u>and</u> (2) the juvenile threat score is known.

Example Box 1: Overall recruitment score calculation for Altamaha River population of Atlantic sturgeon.

<u>Inputs (from Table 3 above)</u>: adult survival score = 0; spawning score = 4; juvenile presence score = 4; juvenile threat score = -2

$Overall\ Recruitment\ Score = \overline{0, (\overline{(4, 4)} - 2)}$ = (0 + 2) / 2 = **1**

Step Four: Calculate Health Index

The overall health index is derived from the trend score (preferred, if available) or the overall recruitment score (if no trend data exists), combined with the census and/or the effective population scores. The recruitment score (calculated in Step 3) can be viewed as a surrogate measure of the population trend in the absence of empirical trend data. Thus, the overall health index is based on a measure of the population trend, the population size (census) and the genetic diversity of the population (effective). Equal weight is given to the two population scores (effective and census) by first averaging these two scores. This average is then averaged with either the trend score or recruitment score. It should be noted that the population scores are on a smaller scale (-2 to +2) in order to give more weight to the trend/recruitment scores (which range from -4 to +4) in the health index calculation. If only one of the two population estimates (effective or census) is available, the score from that estimate can be used on its own. However, if neither population estimate is available the health index cannot be calculated and will be recorded as "unknown." The formula for calculating the adult population health index is as follows:

$$\text{Adult Health Index} = \overline{[\text{Trend or Recruitment Score}, \overline{(\text{Census Population Score}, \text{Effective Population Score})}]}$$

If a juvenile population estimate is available, a separate juvenile health index can be calculated based on the juvenile census population score. If a juvenile population estimate is not available, the juvenile health index will, by default, be the same as the adult health index.

$$\text{Juvenile Health Index} = \overline{[\text{Trend or Recruitment Score}, \text{Juvenile Census Population Score}]}$$

Example Box 2: Adult population health index calculation for Altamaha River population of Atlantic sturgeon.

Inputs: trend score = NA[1]; overall recruitment score = 1; census population = NA[2];

effective population score = 2

$Health\ index = \overline{1, \overline{(NA, 2)}}$ = (1 + 2) / 2 = **1.5**

[1] Trend score is not available (NA); overall recruitment score used instead.

[2] Census population score not available; use only effective population score

<u>Step Five: Categorize Each River System into a Health Category and Determine Maximum Proportion of the Estimated Population that can be Authorized as Mortality</u>

The health index (calculated in Step 4) will be used to categorize each river system into one of three health categories: *low, medium,* and *high* (Table 5). It is important to note that these categories are only indicative of a river system's relative health/status for purposes of creating a maximum mortality limit (i.e., a system with a health category of "high" should not be interpreted as one that is "healthy" or has achieved its recovery goals). River systems for which a health score could not be calculated due to the lack of population size data (both effective and census) will be classified as "unknown." The health category will determine the maximum proportion of the estimated population that can be authorized as mortality within each river system. For purposes of the Program, these proportions will be referred to as the "relative annual maximum mortality limits". The proposed relative annual maximum mortality limits (0.80 percent, 0.60 percent, and 0.40 percent for high, medium, and low systems, respectively) were set to be conservatively protective of individual river system populations without unnecessarily restricting sturgeon research (Table 5).

Table 5. Conversion of health index into a health category and relative (or proportional) annual maximum mortality.

Health Index	Health Category	Relative Annual Maximum Mortality Limit
≥ 1.5	High	Authorized mortalities will not exceed **0.80 percent** of estimated population size
≥ -1.5 to < 1.5	Medium	Authorized mortalities will not exceed **0.60 percent** of estimated population size
< -1.5	Low	Authorized mortalities will not exceed **0.40 percent** of estimated population size
Unknown	Unknown	Default maximum mortality limit of one fish per year

<u>Step Six: Create Adult and Juvenile Annual Maximum Mortality Limits for Each River System</u>

The annual number of authorized adult and juvenile mortalities will be determined by river system based on the relative annual maximum mortality limits (from Step 5) and the estimated census population size:

*Maximum mortality limit = relative annual maximum mortality limit * estimated census population*

If available, an empirical census population estimate should be used to calculate the maximum mortality limit. If an empirical census population is not available, an adult census population estimate can be calculated from an effective population estimate based on the ratio in Frankham (1995) of 0.1 (i.e., *calculated census population = effective population * 10*). The adult annual maximum mortality limit will be calculated based on the estimated adult census population (empirical or calculated), while the juvenile maximum mortality limit will be calculated based on the estimated juvenile census population (if available). If there is no data available to estimate the juvenile population size, the adult census population will be used instead to calculate the juvenile maximum mortality limit. This is based on the extremely conservative assumption that the juvenile census population will be at least as large as the adult census population.

Example Box 3: Annual adult/subadult maximum mortality limit calculation for the Altamaha River population of Atlantic sturgeon.

Health index = 1.5 → health category = high → relative maximum mortality limit = **0.80 percent**

Effective population = 133

Calculated census population = effective pop. * 10 = 133 * 10 = **1,333**

Adult maximum mortality limit = relative maximum mortality limit * calculated adult census population

= 0.80 percent * 1,333 = **10.66 fish**

For river systems in the "unknown" category (i.e., insufficient available information to estimate a population size), the adult and juvenile maximum mortality limits will both automatically default to one fish per year. This minimal mortality level is designed to protect "unknown" river systems from adverse effects, while still allowing some research activities in an effort to obtain basic information needed for estimating the population size and evaluating population health. As a precautionary measure, the Permits Division will not authorize mortality upfront in permits in unknown river systems; however, captures and procedures with a risk of delayed mortality could still be authorized. If a Permit Holder reports that a mortality has occurred, the researcher will have to stop work as required by the permit while the Permits Division evaluates the incident. Based on that review, the Permits Division will decide given the circumstances of the event (e.g., cause of death, likelihood of recurrence, etc.) whether research can resume, or if all or a portion of research across all permits must stop on that river until the next permit year. If evidence suggests that the river is a natal river (spawning or young juvenile year classes) vs a foraging river (i.e. areas of mixing), the Permits Division will not authorize mortality or further invasive surgical tagging until a population estimate is available for the river system. For rivers that are considered foraging rivers (e.g. Saco River), the Permits Division will apply a mixed-stock analysis in these rivers and mortalities will be applied proportionally to the maximum mortality limits.

Step Seven: Update Status Matrices. Repeat Steps 2 through 6 (above) for River Systems with New or Updated Information

The Permits Division will review the status of sturgeon populations on a regular basis based on the best available information (e.g., NMFS status reviews, technical reports, proceedings of meetings, publications, presentations, and annual report data) to ensure that the level of authorized take does not result in greater impacts to any sturgeon species, DPS or river system than previously anticipated. If a lethal take of sturgeon is reported, the status of the DPS (if known) and river system the fish came from will be assessed at that time. Approximately every two to three years (or earlier if new publications are available) the Permits Division will reassess the status of all Atlantic and shortnose sturgeon river system based on new information available since the prior assessment. This review timeframe generally coincides with the frequency of abundance estimates published by the sturgeon research community for a given river system or DPS. The Permits Division will update the status matrices as necessary to incorporate any new information regarding changes in the status/health of sturgeon populations. The Permits Division will seek input from sturgeon researchers to assist in updating the status matrices. This includes the following information required in annual reports (e.g., recaptures/telemetry of animals undergoing procedures that could result in delay mortality) (See permit template in Appendix C). Steps 2 through 6 (above) will be repeated, as needed, for any river system with new or updated information.

2.5.2 Maximum Mortality Limit Management

The section above described the proposed approach for creating maximum mortality limits for individual river populations of Atlantic and shortnose sturgeon. Maximum mortality limits represents the maximum number of sturgeon mortalities that will be under scientific research permits on an annual basis. This section describes the Permits Division's proposed approach for (1) allocating authorized mortalities among research permits within the maximum mortality limits established for each river system; (2) tracking and monitoring mortalities based on information obtained from researchers; (3) controlling mortality once the annual maximum mortality limit is reached; and (4) addressing scenarios where a maximum mortality limit has been exceeded.

Allocating Authorized Take among Research Permits

As discussed in Section 2.2.1, as part of the proposed Program the Permits Division will establish an annual permit cycle for processing new sturgeon permit applications and major modifications. The annual cycle will allow the Permits Division staff to review and evaluate all requests for directed take (lethal and sub-lethal) of Atlantic and shortnose sturgeon for the upcoming year at one time. For sturgeon take requests, permit applicants are required to specify the species (or DPS), number, type (lethal or sub-lethal), life stage (i.e., egg/larvae, juvenile, subadult/adult), research activity (e.g., capture, lavage, pit tag, fin clip), and sampling location.

The Permits Division may also need to evaluate requests for take where the detrimental effects to the species (or DPS) appear to outweigh the conservation benefits of the proposed research.

Once the annual window for submitting new sturgeon research permit applications is closed, the Permits Division can estimate the number of lethal takes (i.e., mortalities) that are anticipated in the upcoming year for purposes of comparison with the maximum mortality limit levels established for each species, life stage (juvenile and adult), and river system. The following steps will be taken annually to ensure that authorized take will not result in sturgeon mortality levels that exceed the annual maximum mortality limit level:

1. <u>Allocate take requests into particular river systems of origin (i.e., spawning stocks)</u>

Allocation of take requests within the maximum mortality limit will be based on information provided by the researcher in the permit application and genetic studies on sturgeon. For many research scenarios the spawning stock will be obvious, based on the sampling location and life stage sampled (e.g., sampling adults in upriver locations); in other cases, research may be conducted in areas with mixed stocks of sturgeon (e.g., sampling juveniles in an estuary or offshore sampling).

For purposes of the maximum mortality limit for sampling of mixed-stocks, the Permits Division will proportionally allocate requested takes to each spawning stock based on likelihood of occurrence in the particular sampling area. The best available information from genetic studies of sturgeon will be used to approximate the likelihood probabilities for each species and spawning stock based on sampling location. The accuracy of spawning stock likelihood probabilities for mixed-stock sampling is expected to improve over time as more genetic samples are analyzed and research results are published. Sturgeon permits will include a requirement that the permit holder must collect a tissue sample from each captured sturgeon and submit it to the sturgeon genetic tissue bank currently housed and managed by the USGS. Failure to submit genetic samples in a timely manner may result in any of the following actions taken by the Permits Division: (1) deferring or returning modification requests for an active permit until the sample is received, (2) deferring or returning an application for a new permit until the sample is received, or (3) notifying the NMFS Office of Law Enforcement of a permit violation due to failure to provide sample.

The Permits Division will request that USGS (or other future-identified tissue bank) prioritize genetic analysis of "in hand" mortalities, and to the extent possible, analyze samples from mixed-stocks, delayed mortality, and unknown river systems to identify the DPS or river system of origin. The Permits Division will request that USGS, report this information to the researchers, the Permits Division, and the Greater Atlantic Fisheries Regional Office (GARFO) and Southeast Regional Office (SERO). This information will be used to improve predictions regarding the river system of origin for purposes of authorizing mortality, as well as for monitoring actual mortality to avoid exceeding maximum mortality limits. The genetic priorities may change over time depending on recovery needs.

Upon review of the incident, the permit could be modified in a number of ways to ensure that best practices are used to minimize mortality and that annual mortality estimate is not exceeded for any DPS or river system, as applicable. These include options such as

- Improving protocols and methods that resulted in the mortality
- Limiting authorized locations, activities, species/DPSs and/or how many of each may be taken
- Requiring additional coordination among researchers or monitoring of the species

2. Estimate the anticipated number of delayed (or post-release) mortalities resulting from sturgeon research procedures

Some proportion of the sturgeon captured by researchers will likely experience delayed mortality due to research procedures. Delayed mortality due to research procedures is difficult to confirm in field studies since there are many other plausible causes of death. If sturgeon researchers are following the proper protocols, as required in their permit conditions, no delayed mortality or reduced fitness is anticipated to result from the majority of procedures authorized. Based on a comprehensive evaluation of previous research results, the Permits Division anticipates that two of the permitted sturgeon research procedures could result in delayed mortality: internal surgical tagging and gastric lavage. Although data on sturgeon mortality associated with highly invasive procedures are sparse, recent studies suggest adult mortality rates due to internal tagging range from 1.7 percent to 3.0 percent (J. Kahn, NMFS OPR unpublished data collected from 2013-2016; D. Fox, Delaware State University, unpublished data collected 2009-2013). Gastric lavage could result in similar complications post-procedure (e.g., an internal wound or perforation is possible). For purposes of estimating the number of delayed sturgeon mortalities due to either internal tagging or gastric lavage, a mortality rate of 2.5 percent will be applied for internal tagging and lavage procedures on adult/subadult sturgeon. Due to their smaller body size, the risk of delayed mortality when performing internal tagging and lavage procedures on juvenile sturgeon is likely to be greater than it is for adults/subadults. Because very little available information exists on juvenile sturgeon delayed mortality, the Permits Division will assume that the juvenile delayed mortality rate is 5.0 percent (i.e., twice the rate for adults/subadults) as illustrated in Table 6. Because these mortalities will not be actually authorized in permits, rounding of any decimal, or fraction of a fish, in the actual values that result from these percentages will not be necessary.

As with the anticipated “in-hand” mortality rate, the delayed mortality rates from different procedures will be evaluated and adjusted as more data are collected. The expectation is that delayed mortality resulting from sturgeon research procedures will decrease over time as researchers become more proficient, research methods are improved and refined, new research techniques are developed, and new technologies are made available. If supported by the available data, the Permits Division may also choose to apply different delayed mortality rates to account for different procedures and/or sampling under different environmental conditions.

Table 6. Estimated delayed mortality rate resulting from different sturgeon research procedures.

Research Procedure	Sturgeon Life Stage	Estimated Delayed Mortality Rate
Internal Tagging	Adult/sub-adult	2.5 percent
	Juvenile	5.0 percent
Gastric Lavage	Adult/sub-adult	2.5 percent
	Juvenile	5.0 percent
Other Procedures	Adult/sub-adult and Juvenile	No known risk of mortality or impact to individual health/fitness

If new information indicates that other authorized procedures (besides internal tagging and lavage) result in a risk of delayed mortality, the Permits Division will apply a delayed mortality rate to those procedures for purposes of maximum mortality limit management. The Permits Division will also evaluate all new procedures for their risk to cause mortality (or a reduction of fitness) and assign mortality rates, as needed, to new procedures based on the best available data.

3. Determine the anticipated number of "in-hand" sturgeon mortalities resulting directly from capture, handling, or other procedures (i.e., besides internal tagging and gastric lavage)

Sturgeon research mortality resulting directly from capture, handling, or procedures other than internal tagging or lavage is extremely rare. Based on prior researcher reports, from 2012 to present, 14 capture mortalities were reported out of 6,466 Atlantic sturgeon captured (0.22 percent). From 2006 to present, only two capture mortalities were reported out of 7,019 shortnose sturgeon captured (0.03 percent). To estimate anticipated mortality of sturgeon due to capture, handling or other procedures, the Permits Division will use a highly conservative average mortality rate of 0.25 percent of takes authorized per spawning river system and life stage (juvenile and adult). It should be noted that since "in-hand" mortality can be tracked and will be subtracted from the maximum mortality limit level based on empirical data, estimated "in-hand" mortality will only be used for purposes of authorizing take, and will not be subtracted from the actual mortality limit level.

In some permit applications, the researcher will specifically request a specific number of authorized mortalities to account for "in-hand" mortality. If the requested number of "in-hand" mortalities is greater than the anticipated number based on the 0.25 percent mortality rate (after rounding up to the nearest whole number), the Permits Division will consult with the researcher to determine why they are requesting a higher than average mortality rate. The Permits Division will only authorize “in-hand” mortality at a rate higher (after rounding) than the anticipated rate (i.e., initially 0.25 percent) if the researcher can justify the higher rate (e.g., sampling in high-risk areas) and demonstrate that the research design is optimal for the conservation and recovery of the species. If the higher rate is justified, the requested number of “in-hand” mortalities authorized in the permit will be used as the anticipated number for those permits.

As part of the proposed adaptive management approach of the permitting Program, the estimated “in-hand” mortality rate (initially set at 0.25 percent) will be evaluated and adjusted, as necessary, as more data are collected. If supported by the available data, the Permits Division may also choose to apply different estimated “in-hand” mortality rates to account for sampling under different environmental conditions.

4. <u>Account for anticipated annual mortality (delayed and “in-hand”) in the upcoming year from sturgeon research permits issued in prior years</u>

Since not all sturgeon research permits are on the same five-year cycle, some of the permits for research in 2017 have already been issued and are not part of the current year’s pool of permit applicants. In general, in any given year the pool of sturgeon researchers will include both newly issued permits, and permits issued in previous permit application cycles. Anticipated sturgeon mortality from all research (regardless of permit issuance date) must be considered for management of maximum mortality limits. The Permits Division will use the same approach described for new permit applications (see #2 and #3 above) to estimate anticipated mortality (delayed and “in-hand”) for the upcoming year from previously issued sturgeon permits.

Anticipated sturgeon take for the upcoming year from research permits issued in prior years will remain valid <u>unless</u> the maximum mortality limit level for the river system decreases from one year to the next (see Step 7b below). This could occur due to a change in the river system’s health index and/or estimated population size.

5. <u>Combine all anticipated mortality (i.e., delayed/"in-hand”, and new permit applications/ permits issued in prior years) for the upcoming year (Steps 2-4) by species/river system and life stage.</u>

6. <u>Compare total anticipated mortality in the upcoming year (from Step 5) for each species/river system and life stage to the corresponding maximum mortality limit</u>

   - If anticipated mortality is less than or equal to the maximum mortality limit for particular species/river system and life stage go to <u>Step 7a</u>.
   - If anticipated mortality is greater than the maximum mortality limit for particular species/river system and life stage go to <u>Step 7b</u>.

7. a) Issue sturgeon research permits authorizing the numbers and types of take requested in new permit applications for that particular species/river system and life stage

As discussed above, the only exception to this would be if the Permits Division determines that the proposed research will not advance the conservation and recovery of listed sturgeon, or is not optimally designed to minimize lethal and nonlethal take. The Permits Division will use its online database, Authorizations and Permits for Protected Species (APPS), to track the annual number of authorized takes allocated in issued permits and the number of takes reported as used each year. The Permits Division can run a report in APPS to evaluate these takes at any time for each species and population/stock by location.

b) Adjust take levels in sturgeon research permit applications (and previously issued permits, as necessary) to avoid exceeding the maximum mortality limits for each species/spawning stock and life stage

The Permits Division will contact affected researchers to discuss options for reducing the anticipated mortality so as not to exceed the maximum mortality limit. Options may include reducing the number of requested captures or highly invasive procedures, changing the type of invasive procedures used (e.g., external tags instead of internal tags), sampling different life stages, or changing sampling locations to river systems where the maximum mortality limit has not been reached. The Permits Division will initially contact new permit applicants to reduce the anticipated mortalities for a given species/river system and life stage to the maximum mortality limit level. Researchers with permits issued in previous years may also be contacted to assess their flexibility in reducing their authorized take or altering their research approach for the upcoming year. If, as mentioned in Step 4 (above), the maximum mortality limit level for a particular river system decreases from one year to the next and falls below the mortality level anticipated from previously issued permits alone, the Permits Division will contact the affected researchers to discuss options for modifying their previously issued permits to avoid exceeding the maximum mortality limit. Ultimately, the Permits Division will decide how best to modify existing permits and new permit applications such that authorized take levels will not exceed the maximum mortality limits.

Monitoring Sturgeon Mortality

The Permits Division will monitor and update estimated sturgeon mortalities (both delayed and “in-hand”) from capture, handling, and invasive procedures, as information from researchers is made available throughout the year. As a condition of the sturgeon research permit, all “in-hand” mortalities, from capture, handling or a performed procedure, will be reported to the Permits Division within two weeks. Permit Holders will be required to document any lethal takes of sturgeon by completing an incident report and a sturgeon salvage form, and providing a tissue sample for genetic analysis to document and confirm the DPS and/or river of origin determination. Any carcass or body parts must be preserved until sampling and disposal procedures are discussed with the Permits Division.

If a researcher reaches or exceeds their limit of authorized “in-hand” mortalities as specified in their permit, they must stop their research activities and notify the Permits Division. To continue conducting research under their permit they must receive authorization from the Permits Division. Before issuing a permit modification, the Permits Division must determine that the change will not likely result in a mortality level that exceeds the maximum limits for any particular river system and life stage. Upon review of the incident, the permit could be modified in a number of ways to ensure that best practices are used to minimize mortality. These include options such as (1) improving protocols and methods that resulted in the mortality; (2) limiting authorized capture numbers, locations, specific procedures; and (3) requiring additional coordination among researchers or monitoring of the species.

For purposes of monitoring the maximum mortality limits, sturgeon “in-hand” mortalities will include both research directed on the captured species as well as incidental mortality of the species as a non-target species of other sturgeon research. The latter scenario could occur in the event that a sturgeon researcher wants to work solely on one species but could incidentally kill the other sturgeon species during fieldwork involving non-selective capture methods (e.g., trawling). To ensure that such incidental mortality is accounted for, these mortalities will be deducted from the maximum mortality limit as they occur. Such cases are expected to be extremely rare because capture mortalities are rare to begin with and many researchers study both species.

Delayed mortalities (i.e. not observed) resulting from invasive procedures (i.e., internal tagging and gastric lavage) will initially be estimated by applying a fixed mortality rate (see Table 6) to the number of each types of invasive procedure authorized. This estimate will be updated at least annually based on researcher reports indicating the actual number of invasive procedures that were conducted. The Permits Division may request more frequent updates (e.g., bi-annual or quarterly) from researchers regarding the actual number of invasive procedures they have conducted (or plan to conduct in the future) for a more timely assessment of what is left in the annual maximum mortality limit for a given river system.

Confirmed “in-hand” mortalities (from capture, handling or a procedure) and estimated delayed mortalities (from internal tagging and lavage) will initially be assigned to a particular river system based on the proportional probabilities (see Step 1 above *Allocation of take requests into particular river systems of origin*). Researchers will be required to submit all “in-hand” mortalities to the genetic tissue bank in a timely manner. The Permits Division will request that USGS prioritize the genetic analysis of tissue samples as follows in order to inform the function of the maximum mortality limit approach:

1. In-hand mortalities
2. Live fish caught in areas of mixing

3. Live fish undergoing procedures with risk of delayed mortality (currently surgical tagging, followed by lavage)
4. Any fish from an “unknown” river system

Genetic analysis of “in-hand” mortalities will help the Permits Division confirm the DPS or river system of each animal as quickly as possible for managing authorized mortality within the appropriate maximum mortality limit. Prioritization of sample analysis may change over time based on information needs for management and recovery of the species and as new information becomes available on the status of river systems and populations, their movements, and effects of research methods. Results from genetic studies will also improve the ability to predict the proportion of captured fish from each river system for research conducted in mixed-stock areas for purposes of authorizing mortality.

<u>Controlling Mortality Once a Maximum Mortality Limit is Reached</u>

Once the Permits Division determines that a particular annual maximum mortality limit has been reached (i.e., zero mortalities left), all research activities that could potentially result in additional mortality for that spawning stock and life stage would cease for the permit year. This would include not only research conducted within that particular river system, but also research conducted in mixed-stock areas where there is some probability that a fish from spawning stock for which the maximum mortality limit has been reached will be captured. Researchers who can demonstrate that they will have no effect on fish from the population that was excessively taken can continue their research activities. Researchers affected by a maximum mortality limit being reached can request a permit modification (e.g., sample in a different river system or on different life stage) or wait until the following year when the maximum mortality limit will be reset.

<u>Addressing Scenarios where a Maximum Mortality Limit has been Reached or Exceeded</u>

The Permits Division will closely monitor sturgeon mortality throughout the year. Every effort will be made to avoid exceeding the maximum mortality limit levels established for each particular species/river system and life stage. However, it is possible that a maximum mortality limit will be reached or exceeded on rare occasion due to a combination of management uncertainty associated with monitoring mortality and the very small mortality limits created for some river systems. One potential source of uncertainty in managing maximum mortality limits is a catastrophic mortality event due to unpredictable environmental conditions, such as what occurred in the Long Island Sound in 2012 that resulted in nine Atlantic sturgeon mortalities (Permit No. 16323 incident report). Maximum mortality limits may also been reached if actual river of origin results for “in-hand” mortalities and fish subjected to invasive procedures (with some risk of mortality) based on genetic tests are very different from the proportional probabilities used to estimate anticipated mortalities by river system. Given the delay associated with deoxyribonucleic acid (DNA) testing, this information may not be available until after the maximum mortality limit has been reached (or after the year is up). If researchers fail to follow (either intentionally or unintentionally) the research techniques, procedures and conditions as specified in their permits, the result could be a higher number of mortalities than anticipated or authorized. Thus, researcher error is another source of management uncertainty that could result in a maximum mortality limit being exceeded. In addition, for smaller river system populations the maximum mortality limits will be very small (i.e., a couple of fish) to begin with and there is very little margin for error in terms of mortality limit management.

Considering the inherent uncertainty involved with managing sturgeon maximum mortality limits and the possibility of random or unforeseen events that could trigger exceeding a mortality limit, the proposed Program will include a maximum mortality limit buffer that is equal to the maximum mortality limit level (Table 7). The buffer will allow the Permits Division to exceed a mortality limit in any given year. The Permits Division will only utilize the mortality limit buffer as a short-term measure in cases where the maximum mortality limit was unexpectedly exceeded due circumstances beyond its control. To ensure that sturgeon research activities do not result in exceeding maximum mortality limits on a regular basis or over the long-term, any use of a mortality limit buffer will be off-set by reduced mortalities (below the maximum mortality limit level) in subsequent years. The Permits Division will manage mortalities to ensure that the average annual maximum mortality limit (for any given species/river system and life stage) is not

Table 7. Proportion of the population (or number of fish for unknown river systems) that can be authorized as mortality over a 5-year moving average (relative annual maximum mortality limit) and for a single year (relative annual maximum mortality limit plus buffer).

Health Category	**5-Year Average Annual Maximum Mortality Limit (percent)** *Used to authorize mortality in permits* *Upper limit of 5-year moving average*	**Relative Annual Mortality Buffer (percent)** *For unauthorized reported mortalities*	**Relative Annual Maximum Mortality Limit Plus Buffer (percent)** *Used as short-term measure if mortality limit is exceeded* *Upper limit in any given year*
High	**0.80 percent**	**0.80 percent**	**1.60 percent**
Medium	**0.60 percent**	**0.60 percent**	**1.20 percent**
Low	**0.40 percent**	**0.40 percent**	**0.80 percent**
Unknown system	**1 mortality** **per year**	**1 mortality** **per year**	**2 mortalities** **per year**

exceeded over any five year period (i.e., five-year moving average). For example, if a mortality limit is exceeded in Year one, the overage will need to be made up in Years two through five by an equivalent mortality limit underage to avoid exceeding the five-year average. If the maximum mortality limit changes, due to a change in the river system's health category or estimated population size, the five-year moving average will reset to avoid including years with different maximum mortality limit levels in the average (i.e., the year of the mortality limit changes becomes Year one).

2.5.3 Authorizing Mortality of Sturgeon Early Life Stages

Some sturgeon research involves the study of sturgeon eggs and larvae. Take of Atlantic and shortnose sturgeon early life stages (early life stages) will be authorized by the Permits Division as part of the proposed Program. Requests for take of early life stages sturgeon include the following types of take actions: capture/handling/release; intentional (directed) mortality; and incidental take. Sturgeon early life stages requested take numbers by researchers are anticipated to be orders of magnitude smaller than the estimated number of early life stages individuals present within any given river system.

Female Atlantic sturgeon are prolific spawners, with egg production ranging from 400,000 to 4 million eggs per spawning year (Dadswell 2006; Smith et al. 1982; Stevenson and Secor 2000; Van Eenennaam and Doroshov 1998). Fecundity estimates for the smaller shortnose sturgeon range from 27,000 to 208,000 eggs per spawning year (Dadswell et al. 1984). Sturgeon do not spawn every year (e.g., Atlantic sturgeon spawn every two to five years) but the production of eggs/larvae from a single spawning female is quite large compared to the requested early life stages take levels. For example, in the most recent sturgeon permit application cycle (for research in 2017), total requested early life stages take (including lethal and sublethal) across all river systems was 2,470 Atlantic sturgeon and 780 shortnose sturgeon.

To address early life stages take requests as part of the proposed Program, the Permits Division proposes to establish early life stage annual mortality limits for each species and river system (i.e., spawning stock). Different mortality limits will be established by species to account for differences in fecundity between Atlantic sturgeon and shortnose sturgeon. Early life stage mortality limits for each species will be calculated as a fixed proportion (4.0 percent) of the estimated annual female fecundity based on the lower value range in the scientific literature (Atlantic sturgeon 400,000; shortnose sturgeon 27,000):

*Atlantic sturgeon early life stages Annual Maximum Mortality Limit = 4.0 percent * 400,000 = 16,000 eggs/larvae*

*Shortnose sturgeon early life stages Annual Maximum Mortality Limit = 4.0 percent * 27,000 = 1,080 eggs/larvae*

This approach for authorizing sturgeon early life stages mortality is highly conservative since it assumes a single female spawner for an entire river system, a lower bound estimate of fecundity, and a relatively small mortality rate that is well below early life stages natural mortality rates.

2.5.4 Proposed Maximum Mortality Limits for 2017

The proposed initial maximum mortality limits for 2017, based on the approach for creating mortality limits described above, are shown for Atlantic and shortnose sturgeon in Table 8 and Table 9 respectively. These tables represent the five-year average annual mortality limit. The proposed short-term mortality limit for any given year, which includes the buffer shown in Table 7, would be double the five-year average annual mortality limits. These numbers are subject to change as new information regarding sturgeon population sizes, trends, or health index may become available.

2.5.5 Incidental Take of Non-target Species

In addition to the effects on sturgeon, the authorized research activities as part of the proposed action may result in the incidental take of other ESA-listed species. Because incidental take is so rare during sturgeon research, the Permits Division will not authorize such take in individual research permits as this would likely result in the authorization of considerably more take than is necessary. Instead, the Permits Division proposes to implement an annual cap on incidental take for non-target species authorized only within the ITS of this programmatic biological opinion (i.e., the ITS will not be included in the permits themselves, as is currently done). Because the risk of mortality cannot be completely eliminated during certain activities (e.g., trawling), the proposed incidental take annual cap will include a minimal number of lethal takes for each species or species group, in addition to nonlethal take. By not authorizing incidental take by permit, the incidental take cap allows the Permits Division to keep the level of take for non-target species lower for the Program as a whole (which feeds into the baseline of other section 7 consultations).

If a non-target ESA-listed species is incidentally taken, the permit holder must stop work and notify the Permits Division as described. The Permits Division will deduct the incidental take from the Program’s annual cap for that particular non-target species or DPS. The Permits Division will then evaluate the factors that caused the incidental take to occur. As necessary, the permit may be modified to account for any changes in protocols, methods or mitigation measures required to minimize the chance of additional incidental take before research is allowed to resume.

Table 8. . Proposed initial Atlantic sturgeon adult/subadult and juvenile maximum mortality limits for 2017 by spawning stock.

DPS (name)	Spawning Stock	Health Category	Adult/subadult 5-year Average Annual Maximum Mortality Limit	Juvenile 5-year Average Annual Maximum Mortality Limit
Gulf of Maine	Penobscot	Unknown	1.0	1.0
	Kennebec	High	6.9	6.9
	Androscoggin	Unknown	1.0	1.0
	Sheepscot	Unknown	1.0	1.0
	Piscataqua	Unknown	1.0	1.0
	Merrimack	Unknown	1.0	1.0
New York Bight	Taunton	Unknown	1.0	1.0
	Pawcatuck	Unknown	1.0	1.0
	Thames	Unknown	1.0	1.0
	Connecticut	Unknown	1.0	1.0
	Housatonic	Unknown	1.0	1.0
	Hudson	High	24.0	34.5
	Delaware	High	10.4	29.2
Chesapeake Bay	Susquehanna	Unknown	1.0	1.0
	Potomac	Unknown	1.0	1.0
	James	Medium	4.2	4.2
	York	Low	1.2	1.2
	Rappahannock	Unknown	1.0	1.0
	Nanticoke	Unknown	1.0	1.0
	Nottoway	Unknown	1.0	1.0
Carolina	Roanoke	Medium	1.1	1.1
	Tar-Pamlico	Unknown	1.0	1.0
	Neuse	Unknown	1.0	1.0
	Cape Fear	Unknown	1.0	1.0
	Waccamaw/ Pee Dee	Unknown	1.0	1.0
	Black	Unknown	1.0	1.0
	Santee	Unknown	1.0	1.0
	Cooper	Unknown	1.0	1.0
South Atlantic	ACE Basin	Medium	2.4	2.4
	Ashepoo	Unknown	1.0	1.0
	Sampit	Unknown	1.0	1.0
	Broad	Unknown	1.0	1.0
	Savannah	High	6.0	11.8
	Ogeechee	Medium	3.3	3.3
	Altamaha	High	10.6	10.6
	Satilla	Medium	1.4	13.2
	St. Mary’s	Unknown	1.0	1.0
	St. John’s	Unknown	1.0	1.0

Table 9. Proposed initial shortnose sturgeon adult/subadult and juvenile maximum mortality limits for 2017 by spawning stock.

Spawning Stock	Health Category	Adult/subadult 5-year Average Annual Mortality Bank Limit	Juvenile 5-year Average Annual Mortality Bank Limit
St. John	Medium	108.0	108.0
Kennebecasis	High	16.5	16.5
Penobscot	Unknown	1.0	1.0
Kennebec	Medium	57.0	57.0
Androscoggin	High	24.0	24.0
Merrimack	Medium	0.6	0.6
Connecticut	High	12.0	12.0
Hudson	Medium	366.0	366.0
Delaware	High	96.0	96.0
Potomac	Unknown	1.0	1.0
James	Unknown	1.0	1.0
Neuse	Unknown	1.0	1.0
Cape Fear	Medium	0.6	0.6
Waccamaw/ Pee Dee	Unknown	1.0	1.0
Santee	Unknown	1.0	1.0
Cooper	Medium	1.2	1.2
ACE Basin	Unknown	1.0	1.0
Savannah	High	13.4	13.4
Ogeechee	Medium	2.2	2.2
Altamaha	High	50.6	50.6
Satilla	Low	0.4	0.4
St. Mary’s	Unknown	1.0	1.0
St. John's	Unknown	1.0	1.0

On rare occasions, a sturgeon researcher may incidentally take a sturgeon species or individual from a DPS that is not included on their research permit (e.g., capture of a shortnose sturgeon under a permit that only authorizes take of Atlantic sturgeon). The incidental take of sturgeon will not be exempted under the programmatic ITS as described above for other non-target species because incidental take of sturgeon will be considered as part of the takes evaluated pursuant to the maximum mortality limits along with the directed take for that particular species or DPS. If the permit does not specifically authorize the incidental lethal take of sturgeon, the researcher must stop their research activities and notify the Permits Division. Any lethal take (i.e. in-hand mortalities) that may occur in the case of incidental sturgeon capture during research on a permitted sturgeon species will be reported to the Permits Division immediately and will be considered as part of the mortality limit for that particular species, river system, and life stage. Any sturgeon captured alive incidentally will not undergo further procedures and will be released at the site of capture. Unless there is mortality, capture and release of sturgeon does not result in any fitness reduction or long-term adverse effects. Since there is no cap on non-lethal capture of sturgeon in the proposed Program, incidental captures have no impact on the take limits or on the overall fitness of the population.

2.6 Internal Program Review

The Permits Division will conduct an internal review of the Program after one full annual permit cycle, including submission of annual reports, has been completed. The internal review will evaluate program operations to determine whether resources (time, staff, expertise etc.) need adjustment, identify challenges or problems that arose and lessons learned, and identify ways to improve how the program functions. Specific aspects of the proposed Program that will be assessed include:

- Permit cycle – Are the majority of applicants submitting requests on time? Is the volume of requests in a cycle manageable in addition to other workload? Is the 6-month processing window adequate?
- Take allocation – Are the levels of mortality requested and authorized in line with what was expected based on past data? Are the maximum mortality limits and incidental take estimates sufficient or over-estimated?
- Reporting schedule – Are Permit Holders submitting annual and incident reports on time? Are we getting the details we need?
- Lessons learned – What other challenges or problems arose and how were they resolved? Does the process need revision?
- Future issues – Do we foresee issues on the horizon based on funding announcements, trending research interests, species status, new information/papers, etc., that would require re-initiation?

The Permits Division will continue to conduct internal reviews of their Program on a regular basis (approximately every 12-16 months), as other taxa/species programmatic consultations are completed, or more frequently as needed.

2.7 Reporting to the Interagency Cooperation Division

Continued close collaboration and an on-going dialogue between the Permits Division and the Interagency Cooperation Division will be an important component of the proposed adaptive approach to managing the Program. The Permits Division will summarize and compile information from the annual reports submitted by sturgeon researchers (Appendix D) into an annual Program report. The Permits Division will submit the annual Program report to the Interagency Cooperation Division within 30 days of receiving the annual reports from permit holders. The annual Program report to the Interagency Cooperation Division will synthesize data such as the number and percentage of takes used for lethal and nonlethal activities, the frequency of observed effects of activities, and the number and kinds of non-target species incidentally taken. The Permits Division's annual Program reports will also include notifying the Interagency Cooperation Division of any proposed changes to mortality rates used to estimate lethal take allowances (i.e. mortality limits). For example, if new information suggests that a different mortality rate for in-hand or delayed mortalities for a specific procedure is appropriate, this information will be conveyed and discussed in the report, including references to literature and other reports that were the basis for this determination. If new information indicates that a procedure has greater impacts than those analyzed in this biological opinion, the Permits Division will consult, either informally or formally depending on the nature of the proposed program change, with the Interagency Cooperation Division and use the additional documentation to modify individual permits as needed. Permits may be modified to authorize or remove procedures or add or revise mitigation measures to limit the potential impacts of authorized activities. The timing of the annual Program report will allow for the Permits Division to confer with the Interagency Cooperation Division on such matters before the next year's permit cycle begins. The Permits Division will also continue to work closely with the Interagency Cooperation Division to routinely check-in (e.g., every 5 years or more frequently as needed) on how the Program is functioning overall, and to determine whether new information indicates that the Permits Division should request re-initiation of this consultation.

2.8 Adaptive Management Approach

Adaptive management will be an integral component of the proposed Program. Through adaptive management the Permits Division will ensure they are meeting the dual Program objectives of authorizing sturgeon research necessary for the conservation and recovery of ESA-listed species while mitigating and minimizing any adverse effects on individuals fish and sturgeon populations. The proposed Program is designed to be dynamic and adaptive in response to changes over time affecting species status, population trends, species distribution, the impact and magnitude of threats, research levels, research techniques, and the effects of different research methods. At the program level, the Permits Division will continually evaluate and, as appropriate, modify the standard permit terms and conditions and required research protocols and mitigation measures based on new information received from permit holders, published papers, or other relevant sources. Reported incidences of mortality or serious injury to an ESA-listed species will be further investigated by the Permits Division to determine the causal factors, and additional mitigation measures may be added, either program–wide or to an individual permit, as warranted. The Permits Division can adaptively manage individual permits, through either minor or major modifications, as is necessary to avoid exceeding a maximum mortality limit or to mitigate adverse effects from research activities. Any aspect (e.g., species, take numbers, methods, mitigation measures, etc.) of a permit can be modified at any time based on new information on either the potential impacts of permitted activities on the species (or habitat) or the species baseline (e.g., status, threats, habitat range, etc.).

In order to ensure the action is not likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat, the approach used to establish authorized levels of Atlantic and shortnose sturgeon take must be adaptive to incorporate new information regarding changes in the status and health of sturgeon populations over time. As such, adaptive management is a key component of the process for establishing and managing sturgeon maximum mortality limits to continually monitor impacts to the species, DPSs, and river populations and evaluate appropriate levels of authorized take. For example, if threats to a sturgeon population increase over time, the population's health rating will decrease and the maximum proportional mortality authorized for that population will also decrease. In addition, since maximum authorized mortality is a proportion of population size, as the size of a population decreases the maximum number of mortalities authorized within the population will decrease. Information used to establish and manage the maximum mortality limits will also improve over time as more sturgeon research is conducted and results are published. This includes genetic information for identifying fish from different spawning stocks and DPSs, estimated population sizes, population trends, and delayed mortality rates resulting from different procedures.

2.9 Action Area

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 CFR 402.02). The Permits Division proposes to issue ESA section 10(a)(1)(A) scientific research permits for research activities on Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*Acipenser brevirostrum*) within their U.S. east coast range in the wild from Maine to the Florida east coast (Vero Beach, Indian River County), and also in international Canadian waters, occurring where collaborative research is anticipated in the St. John River and Bay of Fundy. Specifically, the action area encompasses the U.S. Exclusive Economic Zone, estuarine systems, and extending to the tidal front or fall line of the major river systems (and their tributaries) within the current known range of each species, including, but not limited to the: St. John (Canada), Penobscot, Kennebec, Androscoggin, Merrimack, Sheepscot, Connecticut, Thames, Housatonic, Long Island Sound, Hudson River, James, York, Rappahannock, Potomac, Patuxent, Patapsco, Pocomoke, Susquehanna, Choptank, Chester, and Nanticoke, Albermarle Sound, Cape Fear, Great Pee Dee, Waccamaw, Santee, Cooper, Ashepoo, Combahee, Edisto, Savannah, Ogeechee, Altamaha, Satilla, St. Marys, Nassau, and St. Johns, and Indian Rivers (Figures 3 and 4).

Research would not be conducted continuously in all locations within the action area; however, NMFS anticipates research could occur in any portion of the action area in the future as available funding or research objectives dictate. As new information becomes available on the target species within this action area, other river systems and areas may be authorized for new sturgeon research. Research may include searches for historical spawning areas above dams or other man-made structures where the species is not studied extensively. Other applications for research permits might include studies of fish passage construction, dam (impediment) removal, presence/absence studies of animals found out of habitat, and investigations of potential range expansion or habitat shift due to other factors such as climate change or prey availability.

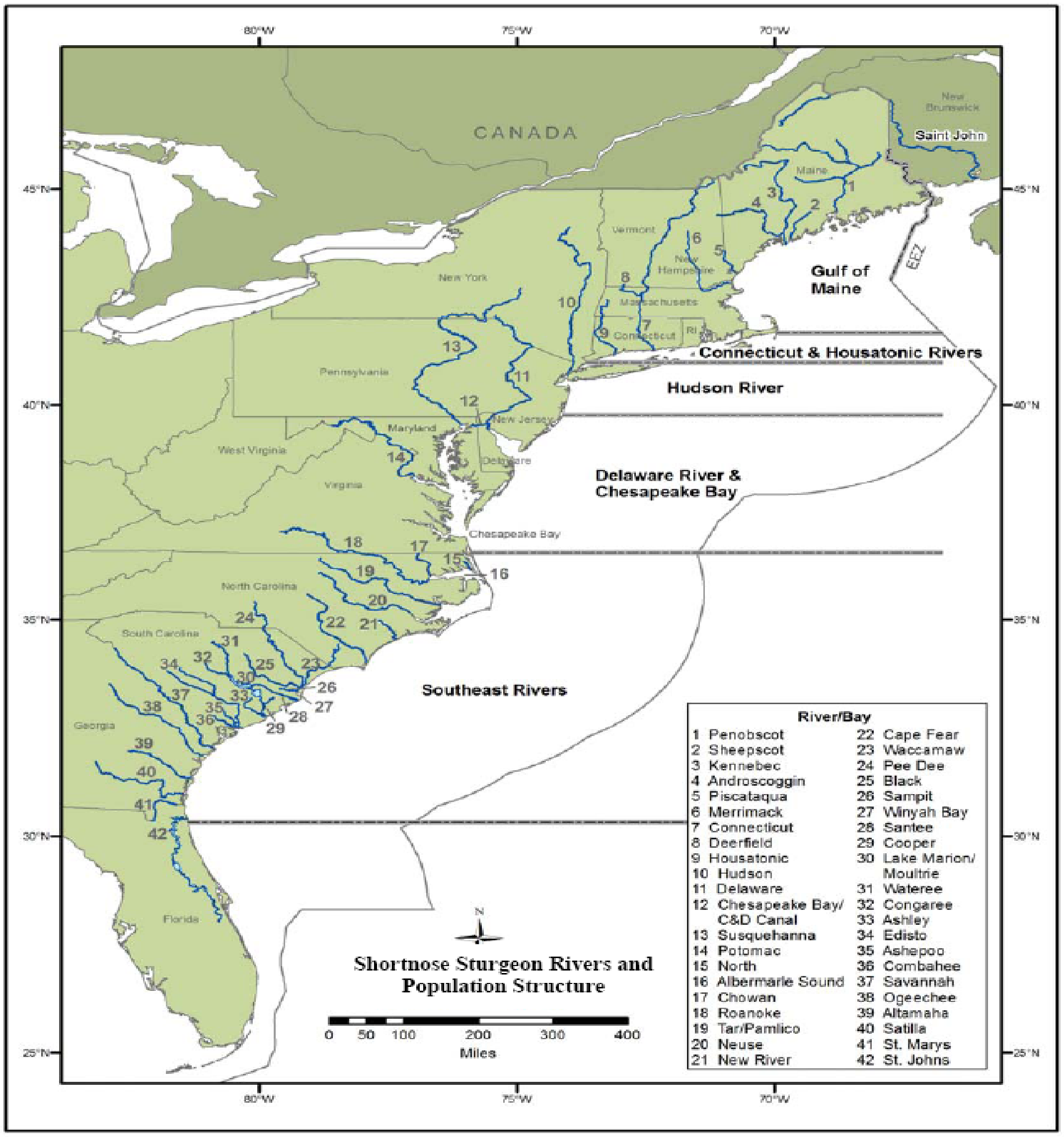

Figure 3. Shortnose sturgeon rivers and population structure (SSSRT 2010). -

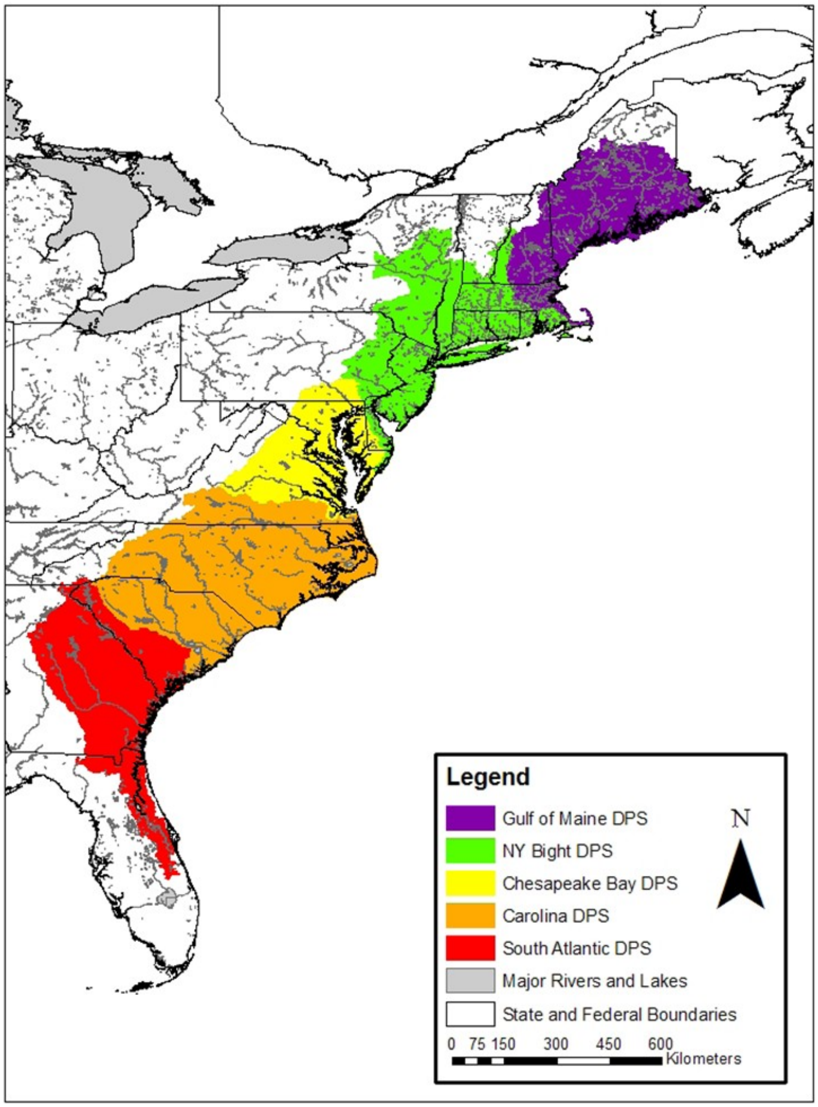

Figure 4. Range and boundaries of the five Atlantic sturgeon Distinct Population Segments.

In addition to the wild populations in the action area defined for native populations above, there are several captive populations of Atlantic and shortnose sturgeon maintained for research and educational display objectives under ESA research and enhancement permits. Although captive populations may change over the years as facilities shift their focus and animals are moved to other approved facilities or euthanized, because these animals are confined to their respective facilities and may not be released into the wild, negative impacts to the species are limited to the individual fish at the facilities.

The USFWS hatcheries and technology centers, having permits to perform scientific research on captive populations of shortnose sturgeon and Atlantic sturgeon include Bears Bluff National Fish Hatchery (Wadmalaw Island, South Carolina); Orangeburg NFH (Orangeburg, South

Carolina) and Warm Springs National Fish Hatchery (Warm Springs, Georgia); Welaka National Fish Hatchery (Welaka, Florida); and Northeast Fisheries Center (Lamar, Pennsylvania). Additional facilities include NRG Energy Generating Facility (Aquasco, Maryland); University of Maryland Center for Environmental Science Horn Point Laboratory (Cambridge, Maryland); Cooperative Oxford Laboratory (Oxford, Maryland); Manning Hatchery (Maryland Department of Natural Resources), Brandywine, Maryland); and Crane Aquaculture Laboratory (University of Maryland, College Park, Maryland).

2.10 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent use, apart from the action under consideration. We have determined that there are no interrelated or interdependent actions resulting from the Permits Division implementation of the proposed Program for the issuance of permits for research activities on Atlantic sturgeon and shortnose sturgeon.

3 THE ASSESSMENT FRAMEWORK

Section 7 (a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions either are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"To jeopardize the continued existence of an ESA-listed species" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). The jeopardy analysis considers both survival and recovery of the species.

Section 7 assessment involves the following steps:

1. We identify the proposed action and those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on the physical, chemical, and biotic environment within the action area, including the spatial and temporal extent of those stressors.
2. We identify the ESA-listed species and designated critical habitat that are likely to co-occur with those stressors in space and time.
3. We describe the environmental baseline in the action area including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation, impacts of state or private actions that are contemporaneous with the consultation in process.
4. We identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or subpopulations to which those individuals belong. We also consider whether the action "may affect" designated critical habitat. This is our exposure analysis.
5. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how the action may affect designated critical habitat. This is our response analyses.
6. We assess the consequences of these responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. This is our risk analysis.
7. The adverse modification analysis considers the impacts of the proposed action on the essential habitat features and conservation value of designated critical habitat.
8. We describe any cumulative effects of the proposed action in the action area. Cumulative effects, as defined in our implementing regulations (50 CFR §402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.

9. We integrate and synthesize the above factors by considering the effects of the action to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:
   a) Reduce appreciably the likelihood of both survival and recovery of the ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or
   b) Reduce the conservation value of designated or proposed critical habitat. These assessments are made in full consideration of the status of the species and critical habitat.
10. We state our conclusions regarding jeopardy and the destruction or adverse modification of designated critical habitat.

If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative to the action. The reasonable and prudent alternative must allow the action to proceed without likely jeopardy or destruction of adverse modification of critical habitat, and must meet other regulatory requirements.

To comply with our requirement to use the best scientific and commercial information available we conducted electronic and manual searches to identify information relevant to the potential stressors and responses of the fish species and sea turtles that may be affected by the proposed action. Sources included journal articles, published reports, grey literature, Internet sites, unpublished data, and personal communications. This information was evaluated to draw conclusions about the likely risks to the continued existence of these species and the conservation value of their critical habitat.

4 STATUS OF ENDANGERED SPECIES ACT PROTECTED RESOURCES

This section identifies the ESA-listed species that potentially occur within the action area (see Section 2.7) that may be affected by the Permits Division implementation of the proposed Program. It then summarizes the biology and ecology of those species and what is known about their life histories in the action area. The ESA-listed species potentially occurring within the action area, along with their regulatory status, are shown in Table 10.

4.1 Species and Critical Habitat Not Likely to be Adversely Affected

NMFS uses two criteria to identify the ESA-listed species or critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are interrelated to or interdependent with the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitats that are exposed to a potential stressor but are likely to be unaffected by the exposure is also not likely to be adversely affected by the proposed action. We applied these criteria to the ESA-listed species in Table 10 and we summarize our results below.

An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly beneficial, insignificant or discountable. Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected. Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. That means the ESA-listed species may be expected to be affected, but not harmed or harassed. Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact an ESA-listed species), but it is very unlikely to occur.

For this opinion, we determine that the following species and designated/proposed critical habitats are not likely to be adversely affected by the Permits Division's implementation of their proposed Program:

Table 10. Threatened and endangered species that may be affected by the proposed action.

Species			
–			
Blue whale (*Balaenoptera musculus)*	E – 35 FR 18319	-- --	07/1998
Fin whale (*Balaenoptera physalus)*	E – 35 FR 18319	-- --	75 FR 47538
North Atlantic Right whale (Eubalaena glacialis)	E – 73 FR 12024	81 FR 4837	70 FR 32293
Sei whale (Balaenoptera borealis)	E – 35 FR 18319	-- --	76 FR 43985
Sperm whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584
Sea Turtles			
Green turtle (*Chelonia mydas*) – North Atlantic	T – 81 FR 20057	63 FR 46693[b]	63 FR 28359
Hawksbill turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693 [b]	57 FR 38818
Kemp's ridley turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	75 FR 12496
Olive ridley turtle (*Lepidochelys olivacea*)	T – 43 FR 32800	-- --	-- --
Leatherback turtle (*Dermochelys coriacea*)	E – 61 FR 17	44 FR 17710 [b]	63 FR 28359
Loggerhead turtle (*Caretta caretta*) – Northwest Atlantic	E – 76 FR 58868	79 FR 39856	63 FR 28359
Fishes			
Shortnose sturgeon (*Acipenser brevirostrum*)	E – 32 FR4001	-- --	63 FR 69613
Atlantic sturgeon (*Acipenser oxyrinchus*)			
Atlantic sturgeon – GOM	T – 77 FR 5880	81 FR 35701 [a]	-- --
Atlantic sturgeon – New York Bight	E - 77 FR 5880	81 FR 35701 [a]	-- --
Atlantic sturgeon – Chesapeake Bay	E - 77 FR 5880	81 FR 35701 [a]	-- --
Atlantic sturgeon – Carolina DPS	E – 77 FR 5914	81 FR 41926 [a]	-- --
Atlantic sturgeon – South Atlantic	E – 77 FR 5914	81 FR 41926[a]	-- --
Atlantic salmon – GOM	E – 74 FR 29344	74 FR 29300	70 FR 75473
Smalltooth sawfish (*Pristis pectinata*)	E – 68 FR 15674	74 FR 45353[b]	74 FR 3566
	Plants		
*Johnson's seagrass (*Halophila johnsonii*)*	T – 63 FR 49035	65 FR 17786	67 FR 62230

NOTE: [a] denotes proposed critical habitat; [b] denotes designated critical habitat that is entirely outside of the action area and will not be further addressed in this opinion.

Species Not Likely to be Adversely Affected

- Blue whale
- Fin whale
- Sei whale
- Sperm whale
- North Atlantic right whale
- Johnson's seagrass

Designated Critical Habitat Not Likely to be Adversely Affected

- North Atlantic right whale
- Northwest Atlantic DPS loggerhead turtle
- Gulf of Maine (GOM) DPS Atlantic salmon
- Johnson's seagrass

Proposed Critical Habitat Not Likely to be Adversely Affected

- Atlantic sturgeon: GOM DPS, New York Bight DPS, Chesapeake Bay DPS, Carolina DPS, and South Atlantic DPS

The rationale for reaching the determination of "not likely to adversely affect" for each of these species and/or their designated (or proposed) critical habitat is discussed below.

4.1.1 Large Whale Species

ESA-listed endangered blue, fin, North Atlantic right, sei, and sperm whales could potentially occur within the action area. While it is possible that these whales could be subject to harassment and/or harm from sturgeon research vessels or entanglement in sturgeon netting gear, the likelihood of this occurring is so low that we consider these effects discountable. The large majority of sturgeon research takes place in rivers, estuaries, and near-shore areas where these large whale species are generally not found. There are no known encounters between sturgeon researchers permitted by the Permits Division and large whales. In addition to the small spatial overlap, mitigation measures are in place to prevent interactions and adverse effects from occurring. In the event that marine mammals are encountered during permitted research activities, as a condition of their permit researchers must follow the NMFS Greater Atlantic Region Marine Mammal Approach and Viewing Guidelines. Additionally, all nets must be closely attended and continuously monitored. Netting cannot be initiated if marine mammals are within the vicinity (100-foot radius) of the planned netting area, and nets must be pulled if marine mammals enter the research area and remain there after nets have been deployed. Additional mitigation measures implemented by researchers include the use of fishing gear that complies with the Harbor Porpoise Take Reduction Plan and the Atlantic Large Whale Take

Reduction Plan, and the use of nets outfitted with acoustic pingers to deter marine mammal interactions.

Given the extremely low likelihood of interaction between sturgeon research activities and large whales and the mitigation measures in place, we determine that the proposed action is not likely to adversely affect blue whales, fin whales, North Atlantic right whales, sei whales, or sperm whales.

4.1.2 North Atlantic Right Whale Critical Habitat

Critical habitat was initially designated for the North Atlantic right whale in 1994 and replaced by NMFS with a new designation in January 2016. The new critical habitat designation includes Unit 1 in the GOM and Georges Bank region and Unit 2 off the Southeast U.S. coast. The physical and biological features essential to the conservation of the North Atlantic right whale found in these areas include a combination of the following biological and physical oceanographic features: 1) the physical oceanographic conditions and structures of the GOM and Georges Bank region that combine to distribute and aggregate *C. finmarchicus* for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes; 2) low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer to that copepods are retained in the basins; 3) late stage *C. finmarchicus* in dense aggregations in the GOM and Georges Bank region; and 4) diapausing *C. finmarchicus* in aggregations in the GOM and Georges Bank region. The essential physical and biological feature for right whale calving habitat include: 1) calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale; 2) sea surface temperatures from a minimum of 7°C and never more than 17°C; 3) water depths of 6-28 m, where these features simultaneously co-occur over contiguous areas of at least 231 nm^2 of ocean waters during the months of November through April.

While the proposed research activities would directly overlap with these essential features, very few if any, effects are possible. The proposed activities would not significantly alter the physical or oceanographic conditions within the action area, as only minor changes in water flow and current would be expected from vessel traffic, and no changes in ocean bathymetry would occur. In addition, sturgeon researchers would be targeting subadult and adult sturgeon, hence large mesh gillnets or trawls would be used as the primary method of capture. These capture gears will not collect *C. finmarchius*, an important food source of North Atlantic right whales. While some research activities may temporarily disturb *C. finmarchius* aggregations, these disturbances will be minimal in time and space. Finally, the proposed activities would in no way alter the sea state, temperature, or water depth, and so effects to these features are deemed discountable

Given the biological and physical features used to designate critical habitat, we determine that the proposed action is not likely to adversely affect North Atlantic right whale designated critical habitat.

4.1.3 Loggerhead Sea Turtle Northwest Atlantic Critical Habitat

Critical habitat was designated on July 10, 2014 for the Northwest Atlantic DPS of loggerhead sea turtle and includes 38 occupied marine areas in the Atlantic Ocean and Gulf of Mexico. These areas contain one or a combination of habitat types: nearshore reproductive habitat, foraging habitat, winter area, breeding areas, constricted migratory corridors, and/or *Sargassum* habitat. Potential overlap between sturgeon research activities and loggerhead critical habitat occurs in the following areas and habitat types:

- North Carolina constricted migratory habitat, offshore winter habitat, and nearshore reproductive habitat
- South Carolina nearshore reproductive habitat
- Georgia nearshore reproductive habitat
- Florida (east coast) breeding habitat, constricted migratory habitat, and nearshore reproductive habitat
- U.S. Exclusive Economic Zone east coast *Sargassum* habitat

Sturgeon research generally focuses on rivers, estuaries and nearshore areas rather than offshore areas. As a result we anticipate very minimal spatial overlap between sturgeon research activities and the offshore winter areas and *Sargassum* habitat designated as loggerhead critical habitat (i.e., any effects will be insignificant).

The physical and biological features (formerly referred to as primary constituent elements in the original designation) essential to the conservation of the Northwest Atlantic DPS of Loggerhead Sea Turtles found in nearshore reproductive habitat are (1) nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 CFR 17.95(c) to 1.6 km (1 mile) offshore; (2) waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and (3) waters with minimal man-made structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/ or create excessive longshore currents. The essential physical and biological features found in loggerhead migratory habitat are (1) constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and (2) passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. The essential physical and biological features found in loggerhead breeding habitat are (1) high densities of reproductive male and female loggerheads; (2) proximity to primary Florida migratory corridor; and (3) proximity to Florida nesting grounds.

The anticipated volume, location, and times that sturgeon research capture gear will overlap with loggerhead critical habitat will not result in significant impacts on the movement of sea turtles through the surf zone and outward toward open water or during coastal migrations. Therefore, we determine that the stressors associated with sturgeon research activities will have an insignificant effect on the above-mentioned essential physical and biological features.

Given the biological and physical features used to designate critical habitat, we determine that the proposed action is not likely to adversely affect loggerhead sea turtle Northwest Atlantic DPS designated critical habitat.

4.1.4 Gulf of Maine Atlantic Salmon Critical Habitat

The Atlantic salmon GOM DPS spatial area includes all anadromous Atlantic salmon streams whose freshwater range occurs in watersheds from the Androscoggin River northward along the Maine coast northeastward to the Dennys River, and wherever these fish occur in the estuarine and marine environment. NMFS and the USFWS designated critical habitat for the GOM DPS on June 19, 2009, which identified essential physical and biological features of Atlantic salmon spawning and rearing sites and migration routes. This designated critical habitat overlaps spatially with the action area and the proposed action could potentially affect the following three essential critical habitat features (each of which are discussed below): (1) freshwater and estuary migratory sites free from physical and biological barriers that can delay or prevent adult salmon migrations to natal spawning grounds, (2) freshwater and estuary migration sites free from physical and biological barriers that can delay or prevent emigration of smolts to the marine environment, and (3) freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.

The first essential feature relates to the ability of migrating adult salmon to reach their natal spawning grounds at the proper time for effective spawning (Bjornn and Reiser 1991). Activities part of the proposed action that could potentially obstruct migratory pathways are the placement of sturgeon research capture gear (i.e., gill nets, trammel nets, trawls, pound/trap nets, beach seines, trot lines, D-nets, and egg mats) in Atlantic salmon freshwater and estuary migratory sites. Although the research gear proposed could create a barrier, the size of this barrier is very small relative to the size of the remaining river or estuary area available for salmon migration. Adult salmon could easily avoid the research gear with insignificant effects on their fitness or ability to reach their natal spawning grounds at the proper time for effective spawning. In addition, sturgeon research permits contain specific conditions protective of GOM DPS Atlantic salmon. These include: (1) specific areas within the Kennebec and Penobscot river systems where gill nets are not allowed, (2) avoiding fishing in documented locations of the Penobscot River and Kennebec complex where Atlantic salmon have been encountered in the past, (3) specific gill net mesh size restrictions in particular areas and during certain times of year when adult salmon are present, and (4) notification of NMFS prior to netting in the defined areas of

GOM salmon run rivers to receive assurances Atlantic salmon passage is no longer anticipated, or is likely finished for the year based on the best available information (see Appendix C for details). Considering the relatively small barrier sturgeon research gear presents and the mitigation measures in place to minimize and avoid migratory obstruction, we conclude that proposed action will not have a significant effect on the ability of adult salmon to reach their natal spawning grounds at the proper time for effective spawning.

The second feature is essential to the conservation of the species because Atlantic salmon smolts require an open migration corridor from their juvenile rearing habitat to the marine environment. As with adult spawning migrations, the timing of smolt emigration is critical and must coincide with physiological adaptation for survival in the marine environment. The proposed gears used to collect sturgeon early life stages (i.e., egg mats and D-nets) could potentially serve as a physical barrier for the emigration of Atlantic salmon smolt. These gears are typically deployed and anchored in a row along the deepest channel bottoms from 100 to 300 m downstream of known or suspected sturgeon spawning areas (NMFS 2017). Salmon smolts, which drift in the upper portion of the water column, would not likely be exposed to capture in D-nets and egg mats which would be anchored to the river bottom. According to the Permits Division, there have been no reports of GOM DPS Atlantic salmon smolts captured in either the Kennebec or Penobscot Rivers by permitted sturgeon researchers using egg mats and D-nets. Therefore, we conclude that the proposed action will not have a significant effect on the ability of GOM DPS salmon smolts to emigrate to the marine environment.

The third feature involves the relative abundance of other fish species present during salmon migrations that may serve as an alternative prey source for salmon predators such as piscivorous fish, seals, porpoises and otters (Saunders et al. 2006). Salmon smolts, in particular, can experience high levels of predation as they pass through the estuary during migration from their freshwater rearing sites to the marine environment. Adult and smolt migrations through the estuary often coincide with the presence of other diadromous species including alewives (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), and striped bass (*Morone saxatilis*). This critical habitat feature is essential to the conservation of the species because without highly prolific abundant alternate prey species such as alewives and shad, the less prolific Atlantic salmon may become a preferred prey species and experience higher predation mortality. We evaluated whether the proposed research activities would appreciably reduce the abundance of riverine or estuarine “buffer prey” for Atlantic salmon adults or smolts within the migratory critical habitat. Alternative prey species are subject to capture as “bycatch” in sturgeon research gears. However, information from past sturgeon research obtained by the Permits Division indicate that the number of other species captured is relatively small when compared to the typically large numbers of these other fish species that occur in these systems during salmon migratory periods. In addition, due to the frequency with which sturgeon researchers check their nets, a large portion of those other species captured are reported to be released alive with very minimal or no sublethal effects. Thus, we conclude that the proposed action will have an insignificant effect on the ability of the critical habitat to provide abundant, diverse native fish communities that serve as a protective buffer against GOM DPS predation.

Overall, we determine that the stressors associated with sturgeon research activities will have an insignificant effect on the essential physical and biological features that support GOM DPS critical habitat. Given the anticipated volume, location, and times that sturgeon research fishing gear will overlap with GOM DPS critical habitat, we do not expect these activities to result in significant impacts on adults migrations, smolt migrations, or alternate prey sources for salmon predators.

Given the biological and physical features used to designate critical habitat, we determine that the proposed action is not likely to adversely affect Atlantic salmon GOM DPS designated critical habitat.

4.1.5 Johnson's Seagrass

Johnson's Seagrass was listed as threatened on September 14, 1998. Johnson's seagrass has been found only along an approximately 200-kilometer stretch of coastline in southeastern Florida between Sebastian Inlet and north Biscayne Bay. Ten areas within the geographic range of Johnson's seagrass were designated as critical habitat for Johnson's seagrass on April 5, 2000. These ten areas and their approximate acreage (in parentheses) include: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel (5.7); a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel (2.0); a portion of the Indian River Lagoon near the Fort Pierce Inlet (4.3); a portion of the Indian River Lagoon, north of the St. Lucie Inlet (2770); a portion of Hobe Sound (900); a site on the south side of Jupiter Inlet (4.3); a site in central Lake Worth Lagoon (15.0); a site in Lake Worth Lagoon, Boynton Beach (95.5); a site in Lake Wyman, Boca Raton (20.0); and a portion of Biscayne Bay (18,757). These designated areas account for approximately 22,574 acres or 9,139 hectares.

While sturgeon research activities considered for this action may overlap with areas where Johnson's seagrass occurs, the Permits Division has placed a condition on sturgeon research permits such that research will not be allowed to be "conducted over, on, or immediately adjacent to Johnson's seagrass or in Johnson's seagrass critical habitat." Additional mitigation measures include setting anchors by hand, setting anchors when water visibility is acceptable, and diligent efforts to recover gear that may be lost to avoid further damage to seagrass habitat and impacts related to "ghost fishing." Routine vessel traffic has been shown to result in scaring of some seagrass species. However, since sturgeon researchers are directed to avoid conducting research in Johnson seagrass critical habitat, we expect minimal vessel traffic in these areas and propeller damage is discountable.

Given the permit conditions and mitigation measures in place, we determine that the proposed action is not likely to adversely affect Johnson's seagrass or its designated critical habitat.

4.1.6 Atlantic Sturgeon Proposed Critical Habitat

NMFS proposed critical habitat for each ESA-listed DPS of Atlantic sturgeon in June of 2016. The following physical and biological features were determined to be essential for Atlantic sturgeon reproduction and recruitment:

1. Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 parts per thousand range) for settlement of fertilized eggs, refuge, growth, and development of early life stages
2. Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5 to 30 parts per thousand and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development
3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support (1) unimpeded movement of adults to and from spawning sites, (2) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and (3) staging, resting, or holding of subadults or spawning condition adults. Water depths in the main river channels must also be deep enough (e.g., ≥1.2m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river
4. Water quality conditions, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support (1) spawning, (2) annual and inter-annual adult, subadult, larval, and juvenile survival, and (3) larval, juvenile, and subadult growth, development, and recruitment (e.g., 13°C to 26°C for spawning habitat and no more than 30°C for juvenile rearing habitat, and 6 mg/L DO for juvenile rearing habitat)

The action area overlaps with areas proposed as critical habitat for all five Atlantic sturgeon DPSs. Of the four critical habitat features listed above, only feature #1 (suitable hard bottom substrate) may be affected by stressors resulting from the proposed action. While the placement of research gear in proposed critical habitat may produce a temporary physical barrier for sturgeon passage (feature #3), because the proposed action is the directed take of sturgeon for research purposes, it is more appropriate to analyze the effects of this stressor on Atlantic sturgeon DPSs rather than on proposed critical habitat (see Section 6 Effects Analysis below).

Of the sturgeon research capture methods in the proposed action, trawling has the greatest potential to affect hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) proposed as critical habitat. However, the Permits Division has mitigation measures in place to avoid and minimize the detrimental impacts of sturgeon research trawls. The following permit conditions will minimize the impacts of trawling on proposed Atlantic sturgeon critical habitat:

- A sonar scanning device and global positioning system (GPS) should be used to monitor bottom characteristics prior to trawling to limit disturbance of substrate while trawling and also to prevent snagging of trawls on the bottom substrate.
- Trawls may be towed at a maximum speed of 2.5 knots and up to 20 minutes per trawl (bottom time) in marine water areas and up 10 minutes in fresh water areas.
- Should a trawl net become snagged on bottom substrate or debris, it would be untangled immediately to reduce stress on captured animals, as well on bottom substrate.
- To lessen benthic disturbances, trawl nets would not be towed over the same location more than once in a 24-hour period, with paths tracked using a GPS system.

The impact of a mobile fishing gear such as trawl nets on the bottom substrate will be related to both fishing intensity and frequency of trawling (Auster and Langton 1999; Watling and Norse 1998). Compared to other fishing methods, trawling is infrequently used by sturgeon researchers to capture sturgeon and this pattern is likely to continue over the course of the Permits Division proposed Program. Additionally, substrates selected for optimal trawling would be free of snags and debris so the disturbance of the bottom and the fish community would be minimized as much as possible. Dovel (1983) found trawling in such open areas was effective for collecting juvenile shortnose sturgeon with minimal impact to bottom substrate Essential Fish Habitat. Considering the mitigation measures in place and the low level of trawling effort anticipated as part of the proposed action, we expect this activity will result in a minimal level of disturbance of the hard bottom substrate features proposed as Atlantic sturgeon critical habitat.

Adverse impacts from gill net fishing may occur from scarring of the seafloor, which may result in a loss of forage habitat. However, previous studies that have investigated impacts of fixed gill nets have determined that they have a minimal effect on the benthos (Carr 1988; Gislason 1995; Kaiser et al. 1996; Stephan et al. 2000). Aside from the potential impacts on coral reef communities, the available studies indicate that habitat degradation from gill nets is minor. While gill net gear can become entangled in rough bottom or can snag and break benthic structures (Carr 1988), this is highly unlikely during sturgeon research where nets are well attended and checked frequently. Similar to the permit condition for trawl nets above, should any type of net or trapping device become snagged on bottom substrate or debris, it would be untangled immediately to reduce stress on captured animals, as well on bottom substrate. Although available information are lacking, we anticipate the use other stationary sampling gear such as trammel nets, pound nets, trap nets, beach seines, trot lines, D-nets, and egg mats will likely have similar minimal and temporary effect on the benthos. Given the proposed level of sampling and the relatively small footprint of these other gears, we anticipate a minimal disturbance of the hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) of proposed Atlantic sturgeon critical habitat. Thus, any adverse effects on proposed Atlantic sturgeon critical habitat resulting from sturgeon research activities will be insignificant.

Given the anticipated insignificant level of effects and existing mitigation measures, we determine that the proposed action is not likely to destroy or adversely modify proposed critical habitat for Atlantic sturgeon GOM DPS, New York Bight DPS, Chesapeake Bay DPS, Carolina DPS, and South Atlantic DPS.

4.2 Species Likely to be Adversely Affected

This opinion examines the status of each species that is likely to be affected by the proposed action. The status is determined by considering abundance, age classes present, population trends, and limiting factors and the level of risk that the ESA-listed species faces, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the FR, status reviews, recovery plans, and on the NMFS OPR web site (http://www.nmfs.noaa.gov/pr/species/index.htm).

This opinion also examines the condition of proposed critical habitat, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

4.2.1 Atlantic Sturgeon

Species Description

Five DPSs of Atlantic sturgeon were listed under the ESA in 2012 (Figure 4). The GOM DPS is listed as threatened while the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered. Critical habitat was proposed by NMFS for each DPS on June 3, 2016 (see Section 4.1.5 for details on Atlantic sturgeon proposed critical habitat).

Sturgeon are among the most primitive of the bony fishes. The Atlantic sturgeon is a long-lived (approximately 60 years), late maturing, iteroparous, estuarine dependent species (ASSRT 2007b; Dadswell 2006). Atlantic sturgeon are anadromous, spawning in freshwater but spending most of their subadult and adult life in the marine environment. They can grow to approximately 14 feet (4.3 m) long and can weigh up to 800 pounds (370 kg). Atlantic sturgeon are bluish-black or olive brown dorsally (on their back) with paler sides, a white belly, and have five major rows of dermal "scutes."

This section provides general information on the Atlantic sturgeon coast-wide population including information about the species life history, population dynamics, and status. The subsections that follow provide information and characteristics particular to each of the five-listed DPSs of Atlantic sturgeon.

Species	Common Name	Distinct Population Segment (ESA Status)	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	*Atlantic sturgeon*	*GOM (threatened)*	*2007*	*2012 77 FR 5880*	*No*	*Proposed 2016 81 FR 35701*
		New York Bight (endangered)	*2007*	*2012 77 FR 5880*	*No*	*Proposed 2016 81 FR 35701*
		Chesapeake Bay (endangered)	*2007*	*2012 77 FR 5880*	*No*	*Proposed 2016 81 FR 35701*
		Carolina (endangered)	*2007*	*2012 77 FR 5914*	*No*	*Proposed 2016 81 FR 36077*
		South Atlantic (endangered)	*2007*	*2012 77 FR 5914*	*No*	*Proposed 2016 81 FR 36077*

Life History

The general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, iteroparous, anadromous species. Atlantic sturgeon spawn in freshwater, but spend most of their subadult and adult life in the marine environment. While few specific spawning locations have been identified, at least 21 rivers are known to support reproducing populations. Smith (1985) reported that the timing of the arrival of mature adults into estuaries was temperature dependent and varied with latitude: February in Florida, Georgia, and South Carolina; April in the Delaware and Chesapeake Bay systems; and May-June in the GOM and Gulf of St. Lawrence systems. Traditionally, it was believed that spawning within all populations occurred during the spring summer to early autumn in two tributaries of the Chesapeake Bay (James River and York River, Virginia) and in the Altamaha River, Georgia (Balazik et al. 2012; Hager et al. 2014). A recent study by Balazik and Musick (2015) indicates that two races of Atlantic sturgeon repeatedly spawn during two different times (spring and fall) and places in the James River, and possibly the groups have become genetically distinct from each other. Based on a combination of telemetry data and historical documentation Balazik et al. hypothesize that a dual spawning strategy likely occurs in various degrees throughout the Atlantic sturgeon's range. Smith et al. (2015) identified fall spawning in the Roanoke River. These studies suggest that adult Atlantic sturgeon that show up in the southern estuaries spend the summer in the estuary before making a spawning run in the fall. Farrae et al. (2017) found genetically distinct fall- and spring-spawned Atlantic sturgeon in the Edisto River.

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Smith and Clugston 1997b). Hatching occurs approximately 94 to 140 hours after egg deposition, and larvae assume a demersal existence (Smith et al. 1980). The yolksac larval stage is completed in about 8 to 12 days, during which time the larvae move downstream to rearing grounds over a 6 to 12-day period (Kynard and Horgan 2002). During the first half of their migration downstream, movement is limited to nighttime. During the day, larvae use benthic structure (e.g., gravel matrix) as refugia (Kynard and Horgan 2002). During the latter half of migration when larvae are more fully developed, movement to rearing grounds occurs both day and night. The larvae grow rapidly and are 4” to 5 1/2" long at a month old (MSPO 1993). At this size, the young sturgeon bear teeth and have sharp, closely spaced spine-tipped scutes. As growth continues, they lose their teeth, the scutes separate and lose their sharpness.

Juvenile Atlantic sturgeon continue to move downstream into brackish waters, and eventually become residents in estuarine waters. Juvenile Atlantic sturgeon are resident within their natal estuaries for two to six years, depending on their natal river of origin, after which they emigrate as subadults to coastal waters (Dovel 1983) or to other estuaries seasonally (Waldman et al. 2013). Atlantic sturgeon undertake long marine migrations and utilize habitats up and down the East Coast for rearing, feeding, and migrating (Bain 1997; Dovel 1983; Stevenson 1997). Migratory subadults and adults are normally located in shallow (10-50m) nearshore areas dominated by gravel and sand substrate (Stein et al. 2004a). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers (Bartron 2007; Wirgin et al. 2015). Once in marine waters, subadults undergo rapid growth (Dovel 1983; Stevenson 1997). Despite extensive mixing in coastal waters, Atlantic sturgeon display high site fidelity to their natal streams. In one study by Grunwald et al. (2008), straying between rivers within a DPS would sometimes exceed five migrants per generation, but between DPSs was usually less than one migrant per generation, with the exception of fish from the Delaware River straying more frequently to southern rivers (Grunwald et al. 2008).

Atlantic sturgeon have been aged to 60 years (Mangin 1964) but this should be taken as an approximation because the age validation studies conducted to date show ages cannot be reliably estimated after 15-20 years (Stevenson and Secor 2000). Vital parameters of sturgeon populations generally show clinal variation with faster growth, earlier age at maturation, and shorter life span in more southern systems. Spawning intervals range from one to five years for male Atlantic sturgeon (Collins et al. 2000; Smith 1985) and three to five years for females (Schueller and Peterson 2010; Stevenson and Secor 2000). Fecundity of Atlantic sturgeon is correlated with age and body size, ranging from approximately 400,000 to 8 million eggs (Dadswell 2006; Smith et al. 1982; Van Eenennaam and Doroshov 1998). The average age at which 50 percent of Atlantic sturgeon maximum lifetime egg production is achieved is estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (Boreman 1997).

Atlantic sturgeon feed on molluscs, polychaeta worms, gastropods, shrimps, pea crabs, decapods, amphipods, isopods, and small fishes in the marine environment (Collins et al. 2006a; Guilbard et al. 2007; Savoy 2007). The sturgeon "roots" in the sand or mud with its snout, like a pig, to dislodge worms and molluscs that it sucks into its protrusible mouth, along with considerable amounts of mud. The Atlantic sturgeon has a stomach with very thick, muscular walls that resemble the gizzard of a bird. This gizzard enables it to grind such food items as molluscs and gastropods (MSPO 1993).

Population Dynamics

The Atlantic sturgeon’s historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador, Canada, to the Saint Johns River in Florida (ASSRT 2007b; Smith and Clugston 1997a; Smith and Clugston 1997b). Atlantic sturgeon have been documented as far south as Bermuda and Venezuela (Lee et al. 1980). Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from St. Croix, Maine, to the Saint Johns River, Florida, of which 35 rivers have been confirmed to have had historic spawning populations. Atlantic sturgeon are currently present in 36 rivers, and spawning occurs in at least 21 of these (ASSRT 2007b). Other estuaries along the U.S. Atlantic Coast formed by rivers that do not support Atlantic sturgeon spawning populations may still be important as rearing habitats.

Atlantic sturgeon throughout their range exhibit ecological separation during spawning that has resulted in multiple, genetically distinct, interbreeding population segments. Studies have consistently found populations to be genetically diverse and indicate that there are between seven and ten populations that can be statistically differentiated (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002; Wirgin et al. 2007). However, there is some disagreement among studies, and results do not include samples from all rivers inhabited by Atlantic sturgeon. Overall, the genetic markers used for mixed stock classification resulted in an average accuracy of 85 percent for determining a sturgeon's natal river origin, but an average accuracy of 96 percent for correctly classifying it to one of the five ESA-listed DPSs (Tim King, USGS, unpublished data collected in 2014).

Recent studies indicate that genetically distinct populations of spring and fall-run Atlantic sturgeon may exist within a given river system (Balazik and Musick 2015; Farrae et al. 2017). Farrae et al. (2017) found that fall- and spring-spawned Atlantic sturgeon in the Edisto River are genetically distinct with little gene flow or admixture between groups. Genetic diversity of both groups is on the higher end of published population diversity values.

Status

The 1998 Atlantic sturgeon status review determined that the species did not warrant listing at that time since direct fishing pressure was essentially removed by a coast-wide moratorium on the fishery and water quality had improved substantially since the early 1900s (NMFS and USFWS 1998c). The 1998 status review team, also determined that bycatch of Atlantic sturgeon in other fisheries was unsubstantial and did not pose a threat to the viability of species. The 2007 status review concluded that only a few subpopulations seem to be increasing or stabilizing since 1998, with the majority of subpopulations showing no signs of recovery (ASSRT 2007). New information also suggested that stressors such as bycatch, ship strikes, and water quality were resulting in substantial impacts on subpopulations. The Atlantic Sturgeon Status Review Team (ASSRT) also noted that subpopulation estimates of Atlantic sturgeon remained low, with the lack of recovery attributed to habitat degradation, ship strikes, bycatch and dams. In 2012 NMFS listed the New York Bight and Chesapeake Bay DPSs as endangered and the GOM DPS as threatened on the basis of low population size and the level of impacts and number of threats such as continued degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes to each DPS. Historically, each of these DPSs likely supported more than 10,000 spawning adults (ASSRT 2007b; MSPO 1993; Secor 2002). The best available data indicate that current numbers of spawning adults for each DPS are one to two orders of magnitude smaller (e.g., hundreds to low thousands) than historical levels (ASSRT 2007b; Kahnle et al. 2007). The Carolina and South Atlantic DPSs were estimated to have declined to less than three and six percent of their historical population sizes, respectively (ASSRT 2007b). Both of these DPSs were listed as endangered due to a combination of habitat curtailment and alteration, bycatch in commercial fisheries, and inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

Lacking complete estimates of population abundance across the distribution of Atlantic sturgeon, the NMFS Northeast Fishery Science Center (NEFSC) developed a virtual population analysis model with the goal of estimating bounds of Atlantic sturgeon ocean abundance (Kocik et al. 2013). The Atlantic Sturgeon Production Index (ASPI) was developed to characterize uncertainty in abundance estimates arising from multiple sources of observation and process error, and to complement future efforts to conduct a more comprehensive stock assessment. Model inputs include empirical estimates of post-capture survivors and natural survival, probability estimates of recapture using tagging data from the USFWS sturgeon tagging (PIT and T-bar tags) database, and federal fishery discard estimates from 2006 to 2010.

Based on the ASPI, estimated mean abundance from 2006-2011 was 417,934 fish, with a 95 percent confidence interval of 165,381 to 744,597 fish. This estimate does not include juvenile Atlantic sturgeon that reside year-round in rivers and estuaries. Kocik et al. (2013) partitioned the coast-wide ASPI estimate across DPSs using a Mixed Stock Analysis developed by Wirgin et al. (2015) based on genetic data (n=173 fish) from bycatch in Atlantic coast commercial federal fisheries. The DPS proportions and ocean population estimates are as follows: GOM (11 percent) 45,973 fish; New York Bight (49 percent) 204,788; Chesapeake Bay (14 percent) 58,511; Carolina (4 percent) 16,717; and South Atlantic (20 percent) 83,587 (note: remaining 2 percent partitioned to Canada).

Kocik et al. (2013) produced an alternative Atlantic sturgeon ocean population estimate by dividing the observed total discards by the five-year moving average exploitation rate derived from the ASPI tagging model (139,935 fish; coefficient of variation 21%). This estimate, which is based on more conservative assumptions, is considerably smaller than the ASPI model estimate. Partitioning this more conservative ocean population estimate by Atlantic sturgeon DPS results in the following: GOM 15,393 fish; New York Bight 68,568; Chesapeake Bay 19,590; Carolina 5,597; and South Atlantic 27,987.

An Atlantic sturgeon population abundance estimate was also derived from Northeast Area Monitoring and Assessment Program (NEAMAP) trawl survey data from 2007 to 2012. The NEAMAP estimates were based on sampling in a large portion of the marine range of the five DPSs (Cape Cod, Massachusetts to Cape Hatteras, North Carolina) in known sturgeon coastal migration areas, and during times of year that sturgeon are expected to be migrating north and south. The Atlantic sturgeon population estimates from fall surveys range from 6,980 to 42,160 fish (with coefficients of variation between 0.02 and 0.57), and the estimates from spring surveys range from 25,540 to 52,990 fish (with coefficients of variation between 0.27 and 0.65). These are considered minimum population estimates because the calculation makes the assumptions that the gear will capture all of the sturgeon in the water column along the tow path (i.e., 100 percent net efficiency) and that all sturgeon are within the sampling domain of the survey. Since the NEAMAP survey does not sample in rivers, these estimates will not include river resident young-of-year or juvenile Atlantic sturgeon. The NEAMAP derived estimates only include those subadults that are of a size vulnerable to capture in commercial sink gillnet and otter trawl gear and are present in the marine environment, which is only a fraction of the total number of subadults. Additionally, NEAMAP surveys are not conducted in the GOM or south of Cape Hatteras, NC. Atlantic sturgeon population abundance estimates based on NEAMAP data for catchabilities of 10 percent, 50 percent, and 100 percent are shown in Table 11, along with ASPI estimates for comparison. Partitioned the NEAMAP based estimate a conservative 50 percent efficiency across DPSs, using the proportions developed by Wirgin et al. (2015), results in the following: GOM 7,455 fish; New York Bight 33,210; Chesapeake Bay 9,489; Carolina 2,711; and South Atlantic 13,555.

Table 11. Comparison of estimated Atlantic sturgeon abundance and 95 percent confidence intervals based on two population models.

Model	Model Years	95 percent low	Mean	95 percent high
ASPI	2006-2010	165,381	417,934	744,597
NEAMAP Survey, swept area assuming 100 percent efficiency	2007-2012	8,921	33,888	58,856
NEAMAP Survey, swept area assuming 50 percent efficiency	2007-2012	13,962	67,776	105,984
NEAMAP Survey, swept area assuming 10 percent efficiency	2007-2012	89,206	338,882	588,558

The NMFS OPR developed an Atlantic sturgeon status matrix (Table 12) for the proposed Program based on the best scientific available information (ASSRT 2007b; Hightower et al. 2015; Kahn et al. 2014; Kahnle et al. 2007; NMFS and USFWS 1998c; O'Leary et al. 2014; Peterson et al. 2008; Peterson et al. 2000; Schueller and Peterson 2010). As indicated by the missing cells, information needed to fully assess population status is lacking for many individual Atlantic sturgeon spawning stocks. Population trend estimates are only available for two spawning stocks: York River -3 percent; and Penobscot River 0 percent. Estimated adult survival rate, available for five river populations, ranges from 78 percent (Cape Fear) to 93 percent (York). Spawning is known to occur in one GOM DPS river system (Kennebec), two New York Bight DPS river systems (Hudson and Delaware), two Chesapeake Bay DPS rivers (James and York), one Carolina DPS river system (Roanoke) and six south Atlantic river systems (ACE [Ashepoo, the Combahee, and Edisto] Basin, Savannah, Ogeechee, Altamaha, Satilla, and St. Mary's). Major threats to Atlantic sturgeon, defined as threats that if altered could lead to recovery, are currently identified for three river systems: competition and predation from invasive species in the York and James rivers (J. Kahn, NMFS HQ, pers. comm. to R. Salz, NMFS HQ, December 22, 2016); and commercial fisheries bycatch in the Roanoke river. One or more minor threats, defined as threats that likely result in a low level of mortality, have been identified for several other river populations. The most prevalent minor threats to Atlantic sturgeon are water quality (12 river systems), bycatch (8 river systems), and impingement/entrainment (7 river systems) (Table 12). Effective adult population size is

Table 12. Atlantic sturgeon status matrix developed for the proposed Program[a].

DPS (Name)	Spawning Stock (Name)	Population Trend (%)	Adult Survival Rate (%)	Spawning Frequency (None, Regular, Intermittent)	Juveniles Presence (None, Present, Progression through age classes)	Juvenile Threats Major Threat - one that if altered could lead to recovery; Minor Threat - one that likely results in low level mortality				Empirical Census Pop. (Mean number of individuals)	Effective Pop. (Mean number of individuals)
						Major Threats (List out)	Number of Major Threats (#)	Minor Threats (List out)	Number of Minor Threats (#)		
Gulf of Maine	Penobscot	0%					0	Water Quality, Impinge/Entrain	2		
	Kennebec			Regular	Progression through age classes		0	Water Quality, Impinge/Entrain	2		86.5
	Androscoggin						0		0		
	Sheepscot						0		0		
	Piscataqua						0		0		
	Merrimack						0		0		
New York Bight	Taunton						0		0		
	Pawcatuck						0		0		
	Thames						0		0		
	Connecticut						0		0		
	Housatonic						0		0		
	Hudson			Regular	Progression through age classes		0	Water Quality, By-catch, Impinge/Entrain	3		300.0
	Delaware			Regular	Progression through age classes		0	Water Quality, Impinge/Entrain,	3		130.5
Chesapeake Bay	Susquehanna						0		0		
	Potomac						0		0		
	James			Regular	Present	Comp./Pred./Disease	1	Impinge/Entrain, By-catch	2		70.5
	York	-3%	93%	Regular	Present	Comp./Pred./Disease	1	Impinge/Entrain, By-catch	2	309	9.0
	Rappahannock						0		0		
	Nanticoke						0		0		
	Nottoway						0		0		
Carolina	Roanoke		84%	Regular	Progression through age classes	By-catch	1	Water Quality	1		19.0
	Tar-Pamlico						0		0		
	Neuse						0		0		
	Cape Fear		78%				0	Water Quality, By-catch, Comp./Pred./Disease	3		
	Waccamaw/ Pee Dee						0		0		
	Black						0		0		
	Santee						0		0		
	Cooper						0		0		
South Atlantic	ACE Basin		87%	Regular			0	Water Quality, By-catch	2		40.5
	Ashepoo						0		0		
	Sampit						0		0		
	Broad						0		0		
	Savannah			Regular	Progression through age classes		0	Water Quality, By-catch, Impinge/Entrain	3		74.5
	Ogeechee			Regular	Present		0	Water Quality, By-catch	2		55.5
	Altamaha		84%	Regular	Progression through age classes		0	Water Quality, By-catch	2		132.5
	Satilla			Regular			0	Water Quality	1		24.0
	St. Mary's			Regular			0	Water Quality	1		
	St. John's						0				

[a]Data sources: (Hightower et al. 2015; Kahn et al. 2014; Kahnle et al. 2007; O'Leary et al. 2014; Peterson et al. 2008; Peterson et al. 2000; Schueller and Peterson 2010).

estimated for 11 out of the 21 identified Atlantic sturgeon spawning stocks. A ratio of 10:1 (census:effective population) based on Frankham (1995) was used to derive census population estimates. Relatively large estimated adult Atlantic sturgeon populations are found in the Hudson (3,000), Altamaha (1,325), Delaware (1,305), Kennebec (865), Savannah (745), and James (705). Estimating the number of Atlantic sturgeon spawning adults relies on the assumptions that (1) all adults that migrate into the freshwater portion of a river are native to that river and (2) all adults are making that upstream migration with the intention of spawning. Juvenile Atlantic sturgeon abundance may be a more precise way to measure the status of Atlantic sturgeon populations because it is believed that all age-1 and age-2 juveniles are restricted to their natal rivers (Bain et al. 1999; Dovel 1983), avoiding the assumptions noted above. Published estimates of Atlantic sturgeon juvenile abundance are available in the following river systems: Hudson - 4,314 age 1 fish in 1995 (Peterson et al. 2000); Delaware - 3,656 age 0-1 fish in 2014(Hale et al. 2016); Altamaha - 1,072 to 2,033 age 1-2 fish, 2004-2007 average (Schueller and Peterson 2010); and Satilla – 154 age 1 fish in 2010 (Fritts et al. 2016).

Critical Habitat

See Section 4.1.6 for a detailed discussion of proposed critical habitat for the five Atlantic sturgeon DPSs. Since we concluded (above) that any adverse effects resulting from the proposed Program are not likely to destroy or adversely modify proposed critical habitat for any of the five Atlantic sturgeon DPSs, critical habitat will not be further addressed in the effects analysis of this biological opinion.

4.2.1.1 Gulf of Maine Atlantic Sturgeon

The GOM DPS of Atlantic sturgeon was listed as threatened on February 6, 2012. The GOM DPS historically supported at least four spawning subpopulations; however, today it is suspected that only two extant subpopulations exist (Penobscot and Kennebec rivers) (ASSRT 2007b). The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot rivers. Although surveys have not been conducted to document Atlantic sturgeon presence, subadults may use the estuaries of the smaller coastal drainages (i.e., St. Croix, Machias and Saco rivers) during the summer months (ASSRT 2007b; MSPO 1993).

The Kennebec River is the primary spawning and nursery area for GOM Atlantic sturgeon. Ripe female Atlantic sturgeon with enlarged, fully mature eggs ready to be fertilized have been found in the Kennebec River from mid-July through early August (MSPO 1993). Historical records indicate that the major spawning area for Atlantic sturgeon in the Kennebec River was above head-of-tide between Augusta and Waterville. Prior to any commercial fishing, the Kennebec supported approximately10,000-15,000 spawning adults (ASSRT 2007b; MSPO 1993). The construction of the Edwards Dam at river kilometer (rkm) 64 in 1837 was believed to have caused the commercial sturgeon catch to decline over 50 percent (MSPO 1993). Severe pollution in the river from the 1930's through the early 1970's is believed to have been a major factor in the continued decline of the sturgeon population in the Kennebec. In 2007, the ASSRT concluded that, due to stressors related to poor water quality, dredging, and commercial bycatch, there was a moderate risk (i.e., < 50 percent chance) of the Kennebec subpopulation of Atlantic sturgeon becoming endangered within the next 20 years.

It was speculated that the Penobscot subpopulation was extirpated until a fisherman captured an adult Atlantic sturgeon in 2005, and a gill net survey directed toward Atlantic sturgeon captured seven in 2006 (ASSRT 2007b). Based on the time of year (spring) and size (1400 mm TL), one of the captures in 2006 may have been an adult. The ASSRT concluded that the Penobscot subpopulation also had a moderate risk of becoming endangered due to its potentially small size (likely less than 300 spawning adults), increased dredging projects, and poor water quality (ASSRT 2007b). Within the Penobscot, substrate has been severely degraded by upstream mills, and water quality has been negatively affected by the presence of coal deposits and mercury hot spots. The potential for commercial bycatch was also viewed as a moderate threat to this subpopulation due to its small size.

4.2.1.2 New York Bight Atlantic Sturgeon

The New York Bight DPS was listed as endangered under the ESA on February 6, 2012. The New York Bight, ranging from Cape Cod to the Delmarva Peninsula, historically supported four or more spawning subpopulations, but currently this DPS only supports two known spawning subpopulations: Delaware and Hudson River.

The Delaware River once supported the largest spawning subpopulation of Atlantic sturgeon in the United States, with 3,200 metric tons of landings in 1888 (ASSRT 2007b; Secor 2002; Secor and Waldman 1999). Population estimates based on juvenile mark and recapture studies and commercial logbook data indicate that the Delaware subpopulation has continued to decline rapidly since 1990. Based on genetic analyses, the majority of subadults captured in the Delaware Bay are thought to be of Hudson River origin (ASSRT 2007b). However, a more recent study by Hale et al. (2016) suggests that a spawning population of Atlantic Sturgeon exists in the Delaware River and that some level of early juvenile recruitment is continuing to persist despite current depressed population levels. They estimated that 3,656 (95% confidence interval from 1,935 to 33,041) juveniles (ages 0–1) used the Delaware River estuary as a nursery in 2014. These findings suggest that the Delaware River spawning subpopulation contributes more to the New York Bight DPS than was formerly considered.

The ASSRT found that the Delaware River subpopulation had a moderately high risk (> 50 percent chance) of becoming endangered in the next 20 years, due to the loss of adults from ship strikes. Other stressors contributing to this conclusion that were ranked as moderate risk were dredging, water quality, and commercial bycatch (ASSRT 2007b). Dredging in the upper portions of the river near Philadelphia were considered detrimental to successful Atlantic sturgeon spawning as this is suspected to be the historical spawning grounds of Atlantic sturgeon. Though dredging restrictions are in place during the spawning season, the continued degradation of suspected spawning habitat likely increases the instability of the subpopulation and could lead to its endangerment in the foreseeable future (ASSRT 2007b).

The Hudson River currently supports the largest U.S. subpopulation of Atlantic sturgeon spawning adults. Historically, it supported an estimated 6,000 to 8,000 spawning females (Kahnle et al. 2007; Secor 2002). Long-term surveys indicate that the Hudson River subpopulation has been stable and/or slightly increasing since 1995 in abundance (ASSRT 2007b). Two estimates of immature Atlantic sturgeon have been calculated for the Hudson River stock based on mark-recapture studies. Dovel (1983) estimated that there were approximately 25,000 wild age-1 Atlantic sturgeon in the Hudson River in 1977. Peterson et al. (2000) estimated that there were approximately 4,314 wild age-1 Atlantic sturgeon in the Hudson River in 1995, a decline of about 80 percent from the similarly conducted population estimate of 1977.

The ASSRT concluded that the Hudson River subpopulation had a moderate risk (< 50 percent chance) of becoming endangered in the next 20 years due to the threat of commercial bycatch (ASSRT 2007b). A study conducted by the Atlantic States Marine Fisheries Commission (ASMFC) technical committee in February of 2006 determined that bycatch mortality from the New York Bight sink gill net fishery alone had the potential to impede the recovery of Hudson River Atlantic sturgeon (Hager 2007). Other stressors, such as water quality, have improved since the 1980s and no longer seem to present a significant threat to the Hudson River population (ASSRT 2007b).

4.2.1.3 Chesapeake Bay Atlantic Sturgeon

The Chesapeake Bay DPS was listed as endangered under the ESA on February 6, 2012. Historically, Atlantic sturgeon were common throughout the Chesapeake Bay and its tributaries (Kahnle et al. 1998, Wharton 1957, Bushnoe et al. 2005). Based on U.S. Fish Commission landings data, approximately 20,000 adult female Atlantic sturgeon inhabited the Chesapeake Bay and its tributaries prior to development of a commercial fishery in 1890 (Secor 2002). Chesapeake Bay rivers once supported at least six historical spawning subpopulations (ASSRT 2007b), but today reproducing populations are only known to occur in the James and York Rivers. However, the presence of telemetry tagged Atlantic sturgeon in freshwater portions of Chesapeake Bay tributaries during the summer/fall spawning season (late July to mid-October) suggests that spawning may also occur in the Rappahannock, Potomac, Nanticoke, and Pocomoke Rivers.

The James River supports the largest population of Atlantic sturgeon within the DPS. Balazik et al. (2012) reported empirical evidence that James River Atlantic sturgeon spawn in the fall. As noted above, a more recent study also indicates that Atlantic sturgeon also spawn in the spring in the James River (i.e., dual spawning races)(Balazik and Musick 2015). Genetic analysis of tissue samples suggest effective populations in the James River range from around 40 to 100 (O'Leary et al. 2014). The ASSRT concluded that the James River had a moderately high risk (> 50 percent chance) of becoming endangered in the next 20 years, due to anticipated impacts from commercial bycatch. Dredging and ship strikes were also identified as threats (i.e., moderate risk) that contribute to the risk of extinction for the James subpopulation of Atlantic sturgeon.

The York River has a much smaller population, with annual spawning abundance estimates for 2013 of 75 (Kahn et al. 2014). The effective population size of the York River population ranges from 6 to 12 individuals, the smallest effective population size for any Atlantic sturgeon subpopulation along the Atlantic Coast. The total York River adult Atlantic sturgeon abundance is estimated at 289 individuals. The highest ranked stressor for the York River was commercial bycatch, which received a moderate risk rank (ASSRT 2007b).

4.2.1.4 Carolina Atlantic Sturgeon

The Carolina DPS was listed as endangered under the ESA on February 6, 2012. The Carolina DPS ranges from the Albemarle Sound to the Santee-Cooper River and consists of seven extant subpopulations; one subpopulation (Sampit) is believed to be extirpated. The current abundance of these subpopulations is likely less than 3 percent of their historical abundance based on 1890s commercial landings data (ASSRT 2007b; Secor 2002).

Water quality issues represented either a moderate or moderately high risk for most subpopulations within this DPS (ASSRT 2007b). The Pamlico Sound suffers from eutrophication and experiences periodically low DO events and major fish kill events, mainly in the Neuse Estuary of the Sound. The Cape Fear River is a blackwater river; however, the low DO concentrations in this river can also be attributed to eutrophication. Water quality is also a problem in Winyah Bay, where portions of the Bay have high concentrations of dioxins that can adversely affect sturgeon development (Chambers et al. 2012). Commercial bycatch was a concern for all of the subpopulations examined by the ASSRT. The Cape Fear and Santee-Cooper rivers were found to have a moderately high risk (> 50 percent) of becoming endangered within the next 20 years due to impeded habitat from dams. The Cape Fear and Santee-Cooper are the most impeded rivers along the range of the species, where dams are located in the lower coastal plain and impede between 62-66 percent of the habitat available between the fall line and mouth of the river (ASSRT 2007b). The ASSRT concluded that the limited habitat in which sturgeon could spawn and utilize for nursery habitat in these rivers likely leads to the instability of these subpopulations and to the entire DPS being at risk of endangerment.

4.2.1.5 South Atlantic Atlantic Sturgeon

The South Atlantic DPS was listed as endangered under the ESA on February 6, 2012. This DPS historically supported eight spawning subpopulations but currently supports five extant spawning subpopulations (ASSRT 2007b). Of these subpopulations, the Altamaha and ACE Basin support the largest number of spawning adults, and are considered the second and third largest Atlantic sturgeon subpopulations within the United States, respectively. The current abundance of these subpopulations are suspected to be less than 6 percent of their historical abundance, extrapolated from the 1890s commercial landings (ASSRT 2007b; Secor 2002). Peterson et al. (2008) reported that approximately 324 and 386 adults per year returned to the Altamaha River in 2004 and 2005, respectively. Schueller and Peterson (2010) reported that age-1 and -2 Atlantic sturgeon population densities ranged from about 1,000 to 2,000 individuals over a 4-year period from 2004 to 2007 in the Altamaha River. Few captures have been documented in subpopulations other than the Altamaha and ACE Basin within this DPS, and these smaller systems are suspected to contain less than 1 percent of their historic abundance (ASSRT 2007b).

Bahr and Peterson (2016) estimated the Savannah River to contain between 528 and 597 age-1 juveniles from 2013-2015. The ASSRT found that the South Atlantic DPS of Atlantic sturgeon had a moderate risk (> 50 percent) of becoming endangered in the next 20 years due primarily to dredging, degraded water quality, and commercial fisheries bycatch.

4.2.2 Shortnose Sturgeon

Species Description

Shortnose sturgeon were initially listed as endangered on March 11, 1967 under the Endangered Species Preservation Act of 1966. In 1994, the species was listed as endangered throughout its range under the ESA (38 FR 41370). Critical habitat has not been designated for shortnose sturgeon. Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada to the St. Johns River in Florida (see Section 2.9, Figure 3).

Species	Common Name	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser brevirostrum	Shortnose sturgeon	Endangered	2010	1967 (32 FR 4001)	1998 (63 FR 69613)	Not designated

The shortnose sturgeon is the smallest of the three sturgeon species that occur in eastern North America; they grow up to 4.7 feet (1.4 m) and weigh up to 50.7 pounds (23 kg). It has a short, conical snout with four barbells in front of its large underslung mouth. Five rows of bony plates (called scutes) occur along its body: one on the back, two on the belly, and one on each side. The body coloration is generally olive-yellow to gray or bluish on the back, and milky-white to dark yellow on the belly. The peritoneum (body cavity lining) is black.

Life History

The shortnose sturgeon is a relatively slow growing, late maturing, and long-lived fish species. The maximum recorded size of shortnose sturgeon was collected from the Saint John River, Canada, measuring 143 cm TL and weighed 23 kg (Dadswell et al. 1984). Shortnose sturgeon typically live longer in the northern portion of their range compared to the southern portion (Gilbert 1989). The maximum ages reported of female shortnose sturgeon by river system include 67 years for the St. John River (New Brunswick), 40 years for the Kennebec River, 37 years for the Hudson River, 34 years for the Connecticut River, 20 years for the Pee Dee River, and ten years for the Altamaha River (Dadswell et al. 1984; Gilbert 1989). Female shortnose sturgeon generally outlive and outgrow males, which seldom exceed 30 years of age (Dadswell et al. 1984; Gilbert 1989). Thus, the ratio of females to males among young adults is 1:1, but changes to approximately 4:1 for fish larger than three feet (90 cm). Shortnose sturgeon also exhibit sexually dimorphic growth and maturation patterns across latitudes (Dadswell et al. 1984). In the north, males reach maturity at 5 to 11 years, while females mature between 7 and 18 years. Shortnose sturgeon in southern rivers typically grow faster, mature at younger ages (2 to 5 years for males and 4 to 5 for females), but attain smaller maximum sizes than those in the north which grow throughout their longer lifespans (Dadswell et al. 1984).

Shortnose sturgeon are amphidromous, inhabiting large coastal rivers or nearshore estuaries within river systems (Buckley and Kynard 1985; Kieffer and Kynard 1993). Sturgeon spawn in upper, freshwater areas, and feed and overwinter in both fresh and saline habitats. Adult shortnose sturgeon typically prefer deep downstream areas with vegetated bottoms and soft substrates. During the summer and winter months, adults occur primarily in freshwater tidally influenced river reaches; therefore, they often occupy only a few short reaches of a river’s entire length (Buckley and Kynard 1985). In the southern end of their range, during the summer adult and juvenile shortnose sturgeon congregate in cool, deep areas of rivers to seek refuge from high temperatures (Flournoy et al. 1992; Rogers and Weber 1995; Weber 1996). Older juveniles or subadults tend to move downstream in the fall and winter as water temperatures decline and the salt wedge recedes. In the spring and summer, they move upstream and feed mostly in freshwater reaches; however, these movements usually occur above the saltwater/freshwater river interface (Dadswell et al. 1984; Hall et al. 1991). Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1983) but remain within freshwater habitats.

Shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (Dadswell et al. 1984) and as high as 34ºC (Heidt and Gilbert 1979). However, temperatures above 28ºC are thought to adversely affect shortnose sturgeon (Kynard 1997). In the Altamaha River, temperatures of 28 to 30ºC during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. DO also plays a role in temperature tolerance; i.e., increased stress levels and lower temperature tolerance in waters with low DO (Kahn and Mohead 2010; Niklitschek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6 m is necessary for adults to swim unimpeded. This species is known to occur at depths of up to 30 m, but are generally found in waters less than 20 m (Dadswell 1979; Dadswell et al. 1984). Shortnose sturgeon exhibit tolerance to a wide range of salinities from freshwater (Taubert 1980) to waters with salinity of 30 parts-per-thousand (Holland and Yelverton 1973). McCleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10 ppt within a two-hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1997). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989).

While shortnose sturgeon do not undertake the long marine migrations documented for Atlantic sturgeon, telemetry data indicate that shortnose sturgeon do make localized coastal migrations (Dionne et al. 2013). Inter-basin movements have been documented among rivers within the GOM, between the GOM and the Merrimack, between the Connecticut and Hudson rivers, between the Delaware River and Chesapeake Bay, and among the rivers in the Southeast region (Dionne et al. 2013; Fernandes et al. 2010; Finney et al. 2006; Welsh et al. 2002). Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in the spring, and localized, wandering movements in the summer and winter (Buckley and Kynard 1985; Dadswell et al. 1984). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding and overwintering activities. In the spring, as water temperatures reach between 7.0 and 9.7 ºC, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas.

Spawning occurs from late winter/early spring (southern rivers) to mid to late spring (northern rivers) depending upon location and water temperature. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998). Once males begin spawning, one to two years after reaching sexual maturity, they will spawn every other year or annually depending on the river they inhabit (Dadswell 1979; NMFS 1998). Age at first spawning for females is around five years post-maturation, with spawning occurring approximately every three to five years (Dadswell 1979). Spawning is estimated to last from a few days to several weeks.

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996), typically at the farthest upstream reach of the river, if access is not obstructed by dams (NMFS 1998). In the Merrimack River, males continually returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell 1979; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 6.5 to 18ºC, and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell 1979; Hall et al. 1991; Kieffer and Kynard

1996; NMFS 1998). Adult shortnose sturgeon typically leave the spawning grounds shortly after spawning.

Estimates of annual egg production for shortnose sturgeon are difficult to calculate and are likely to vary greatly in this species because females do not spawn every year. Fecundity estimates that have been made range from 27,000 to 208,000 eggs/female, with a mean of 11,568 eggs/kg body weight (Dadswell et al. 1984). At hatching, shortnose sturgeon are 7 to 11 mm long and resemble tadpoles (Buckley and Kynard 1981). In 9 to 12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15 mm TL (Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20 mm TL.

Shortnose sturgeon are benthic omnivores that feed on crustaceans, insect larvae, worms, mollusks (Collins et al. 2006b; Moser and Ross 1995; Savoy and Benway 2004), oligochaete worms (Dadswell 1979) and off plant surfaces (Dadswell et al. 1984). Subadults feed indiscriminately, consuming aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Bain 1997; Dadswell 1979).

Population Dynamics

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along the entire east coast of North America. NMFS's Shortnose Sturgeon Recovery Plan identifies 19 populations based on the fish's strong fidelity to natal rivers and the premise that populations in adjacent river systems did not interbreed with any regularity (NMFS 1998). The Plan recommended that each population be managed separately until further evidence and information allowed for the consideration of potential DPS delineations for shortnose sturgeon. Since the Plan was published in 1998, additional information on straying rates and genetic analysis have been made available. Both mtDNA and nDNA analyses indicate effective (with spawning) coastal migrations are occurring between adjacent rivers in some areas, particularly within the GOM and the Southeast (King et al. 2014). The currently available genetic information suggests that shortnose sturgeon can be separated into smaller groupings that form regional clusters across their geographic range (SSSRT 2010). Differences in life history and ecology further support these genetic groupings or clusters. Both regional population and metapopulation structures may exist according to genetic analyses and dispersal and migration patterns (King et al. 2014; Wirgin et al. 2010). The Shortnose Sturgeon Status Review Team (SSSRT) concluded shortnose sturgeon across their geographic range include five genetically distinct groupings each of which have geographic ecological adaptations: 1) GOM; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast (SSSRT 2010). Three of these regional groups appear to be functioning as a metapopulation: GOM, Delaware/Chesapeake Bay, and Southeast. Very few shortnose sturgeon have been captured in the Chesapeake Bay since the species was listed (40 in the Potomac, 1 at mouth of the Rappahonock and 1 in the James river), and those fish moved back and forth to the

Delaware estuary, which is why it is grouped with the Delaware population. The other two groups (Connecticut/Housatonic and the Hudson River) are thought to be evolutionarily significant. Two additional geographically separate 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 individual shortnose sturgeon move between some of these populations each generation (Quattro et al. 2002; Wirgin et al. 2005; Wirgin et al. 2010). The SSSRT also recommended that each riverine population be considered as a separate management/recovery unit (SSSRT 2010).

The distribution of shortnose sturgeon is disjointed across their range, with northern populations separated from southern populations by a distance of about 400 km near their geographic center in Virginia. There are no spawning areas in the northern part of North Carolina, and a very small population in the Cape Fear estuary. At the northern end of the species' distribution, the highest rate of gene flow (which suggests migration) occurs between the Kennebec, Penobscot, and Androscoggin Rivers. At the southern end of the species' distribution, populations south of the Pee Dee River appear to exchange between one to ten individuals per generation, with the highest rates of exchange occurring between the Ogeechee and Altamaha Rivers (Wirgin et al. 2005). Additionally, these researchers concluded that genetic components of sturgeon in rivers separated by more than 400 km were connected by very little migration, while rivers separated by less than 20 km (such as the rivers flowing into coastal South Carolina) would experience high migration rates (Wirgin et al. 2005). Shortnose sturgeon are known to occur in the Chesapeake Bay, but these fish may be transients from the Delaware River via the Chesapeake and Delaware Canal (Welsh et al. 2002; Wirgin et al. 2010) or remnants of a population in the Potomac River. Shortnose sturgeon were thought to be extirpated from three southern rivers (St. Johns, St. Mary's, and Satilla) (Collins et al. 2000; Rogers and Weber 1995). However, in 2002 one shortnose sturgeon was captured in the St. Johns River (FFWCC 2007), and from 2008-2011 researchers captured and tagged 11 shortnose sturgeon from the Satilla River and one from the St. Mary's River (Fritts and Peterson 2011). These studies suggest either a small remnant population exists or emigration from other populations. Fritts and Peterson (2011) concluded that growth and survival of juvenile shortnose sturgeon were likely hindered during summer months by hypoxic conditions in critical nursery habitats in these rivers occupying the southern range of this species.

Status

The NMFS 1987 assessment qualitatively evaluated threats to riverine populations of shortnose sturgeon with population estimates, and recommended the following: (1) Connecticut (800 adults), Delaware (10,000 adults), and Hudson (27,000 adults) populations should be down-listed to threatened, (2) Kennebec (10,000 adults) and Saint John River (18,000 adults) populations should be de-listed, and (3) all other river populations should remain listed as endangered

(NMFS 1987). These potential modifications to the ESA listing were met with some disagreement from the scientific community in response to the request to public comment. As a result, NMFS did not modify the shortnose sturgeon listing per recommendations from the 1987 Status Review Report. In 1996, NMFS evaluated the status of shortnose sturgeon in the Kennebec River system in response to a petition to de-list (NMFS 1996). NMFS concluded that the petitioned action of de-listing was not warranted due to continued substantial threats to their habitat, inadequacy of existing regulatory mechanisms, and uncertainty regarding the population estimates (61 FR 53893).

The 2010 shortnose sturgeon SRT conducted a three-step risk assessment for shortnose sturgeon at a riverine scale: (1) assess population health, (2) populate a "matrix of stressors" by ranking threats, and (3) review assessment by comparing population health scores to stressor scores. The Hudson River had the highest estimated adult abundance (30,000 to 61,000), followed by the Delaware (12,000), Kennebec Complex (9,000), and Altamaha (6,000) (SSSRT 2010). The SSSRT found evidence of an increasing abundance trend for the Kennebec Complex and ACE Basin populations; a stable trend for the Merrimack, Connecticut, Hudson, Delaware, Winyah Bay Complex, Cooper, Savannah, Ogeechee, and Altamaha populations; and a declining trend only for the Cape Fear population (all other populations had an unknown trend) (SSSRT 2010).

The SSSRT summarized continuing threats to the species in each of the 29 identified populations (SSSRT 2010). Dams represent a major threat to seven shortnose sturgeon populations and a moderate threat to seven additional populations. Dredging represents a major threat to one shortnose sturgeon population (Savannah River), a moderately high threat to three populations, and a moderate threat to seven populations. Fisheries bycatch represents a major threat to one shortnose sturgeon population (Lakes Marion and Moultrie in Santee-Cooper Reservoir System), a moderately high threat to four populations, and a moderate threat to ten populations (SSSRT 2010). Water quality represents a major threat to one shortnose sturgeon population (Potomac River), a moderately high threat to six populations, a moderate threat to 13 populations, and a moderately low threat to one population. Specific sources of water quality degradation affecting shortnose sturgeon include coal tar, wastewater treatment plants, fish hatcheries, industrial waste, pulp mills, sewage outflows, industrial farms, water withdrawals, and non-point sources. These sources contribute to the following conditions that may have adverse effects on shortnose sturgeon: nutrient loading, low DO, algal blooms, increased sedimentation, elevated contaminant levels (mercury, polychlorinated biphenyl [PCBs], dioxin, polycyclic aromatic hydrocarbons [PAHs], endocrine disrupting chemicals, cadmium), and low pH levels (SSSRT 2010). Impingement/entrainment at power plants and treatment plants was rated as a moderate threat to two shortnose sturgeon populations (Delaware and Potomac).

The SSSRT examined the relationship between population health scores and associated stressors/threats for each shortnose sturgeon riverine population (Figure 5) and concluded the following: 1) despite relatively high stressor scores, the Hudson and Kennebec River populations appear relatively healthy; 2) shortnose sturgeon in the Savannah River appear moderately healthy, but their status is perilous; 3) shortnose in the ACE system are of moderate health with low stress and may be most able to recover (SSSRT 2010). Climate warming has the potential to reduce abundance or eliminate shortnose sturgeon in many rivers, particularly in the South (Kynard et al. 2016).

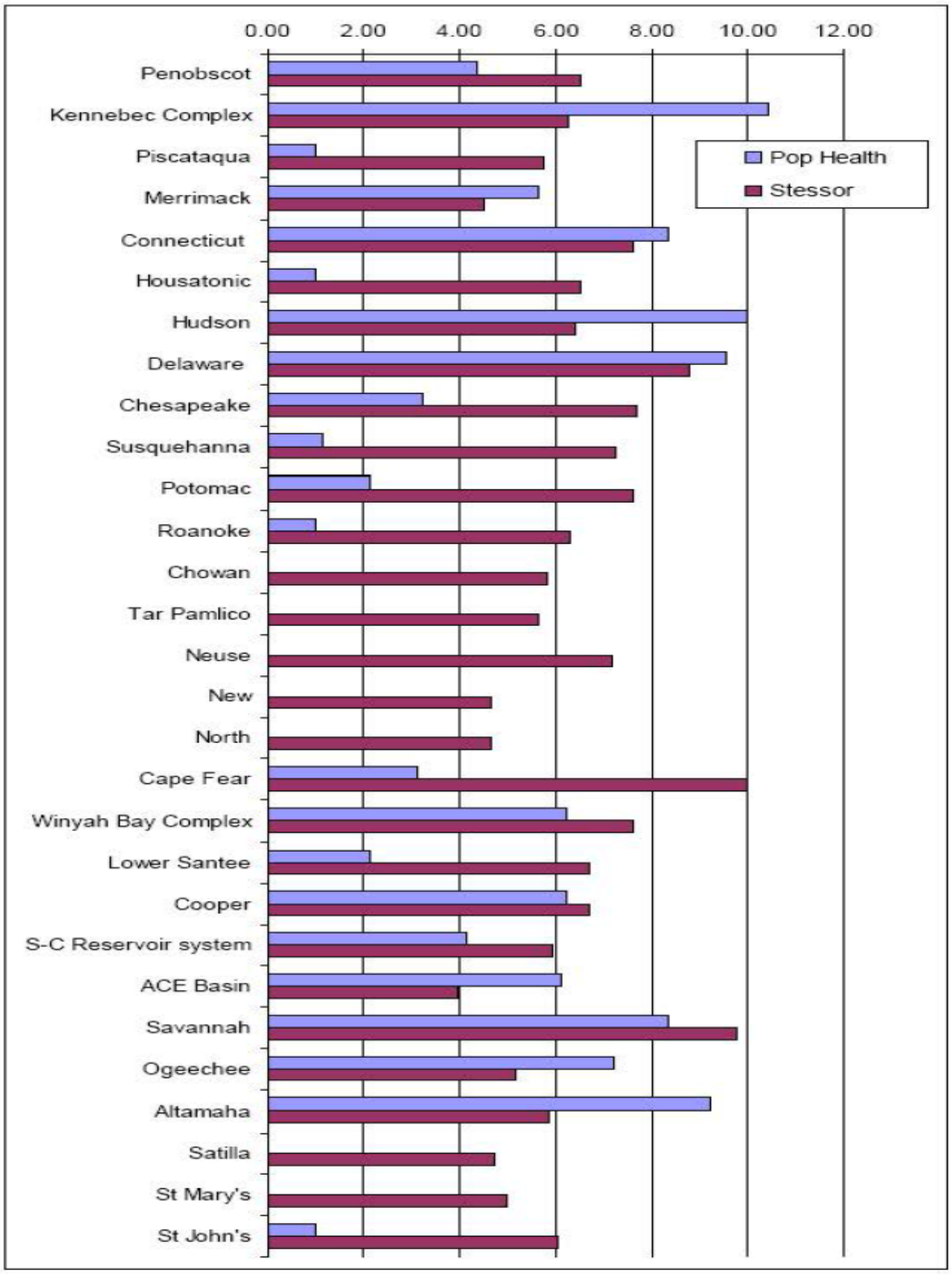

Figure 5. The relationship between population health scores and associated stressors for each shortnose sturgeon river population (SSSRT 2010).

The SSSRT reported results of an age-structured population model using the RAMAS software (Akçakaya and Root 2007) to estimate shortnose sturgeon extinction probabilities for three river systems: Hudson, Cooper, and Altamaha. The estimated probability of extinction was zero for all three populations under the default assumptions, despite the long (100-year) horizon and the relatively high year-to-year variability in fertility and survival rates. The estimated probability of a 50 percent decline was relatively high (Hudson 0.65, Cooper 0.32, Altamaha 0.73), whereas the probability of an 80 percent decline was low (Hudson 0.09, Cooper 0.01, Altamaha 0.23) (SSSRT 2010).

The NMFS OPR developed a shortnose sturgeon status matrix (Table 13) for the proposed Program based on the best scientific available information (Bahr and Peterson 2016; Bahr and Peterson 2017; Bain et al. 1998; Cooke and Leach 2004; COSEWIC 2005; Dadswell 1979; Fritts and Peterson 2011; Hastings et al. 1987; Kynard 1997; NMFS 1998; Oakley and Hightower 2007; Peterson and Bednarski 2013; Peterson and Farrae 2011; Savoy and Benway 2004; Squiers 2003; Squiers et al. 1993; SSSRT 2010). As indicated by the missing cells, information needed to fully assess population status is lacking for many individual shortnose sturgeon spawning stocks. The largest shortnose sturgeon adult populations are found in the Northeastern rivers: Hudson 56,708 adults (Bain et al. 2007); Delaware 12,047 (ERC 2006); and Saint Johns > 18,000 adults (Dadswell 1979). Shortnose sturgeon populations in southern rivers are considerably smaller by comparison. Peterson and Bednarski (2013) documented a three-fold variation in adult abundance (707 to 2,122 individuals) over a 7-year period in the Altamaha River. Bahr and Peterson (2017) estimated the adult shortnose population in the Savannah River was 1,865 in 2013, 1,564 in 2014, and 940 in 2015. Their estimates of juvenile shortnose sturgeon ranged from 81-270 age 1 fish and 123-486 age 2+ fish over the course of the three-year (2013-2015) study period. This study suggests that the Savannah River population is likely the second largest within the South Atlantic (Bahr and Peterson 2017).

Population trend estimates are available for six shortnose sturgeon spawning stocks: St John, Kennebec, Hudson, and Satilla are all decreasing slightly (-1 percent); Delaware and Ogeechee are stable (0 percent). Estimated adult survival rates for shortnose sturgeon are only available for two river populations: Satilla 84 percent and ACE Basin 89 percent. Regular spawning is known to occur in 12 spawning stocks, with intermittent spawning observed in three other river systems (Table 13). Major threats to shortnose sturgeon, defined as threats that if altered could lead to recovery, are currently identified for four river systems: dams in the Connecticut, Santee, and Cooper Rivers and water quality in the St. Mary’s River. One or more minor threats, defined as threats that likely result in a low level of mortality, have been identified for several other river populations. The most prevalent minor threats to shortnose sturgeon are water quality (ten populations), bycatch (eight populations), and impingement/entrainment (six populations) (Table 13).

Table 13. Shortnose sturgeon status matrix developed for the proposed Program[a].

Spawning Stock (Name)	Population Trend (%)	Adult Survival Rate (%)	Spawning Frequency (None, Regular, Intermittent)	Juveniles Presence (None, Present, Progression through age classes)	Juvenile Threats Major Threat - one that if altered could lead to recovery; Minor Threat - one that likely results in low level mortality				Empirical Census Pop. (Mean number of individuals)	Effective Pop. (Mean number of individuals)
					Major Threats (List out)	Number of Major Threats (#)	Minor Threats (List out)	Number of Minor Threats (#)		
St. John	-1%		Regular	Progression through age classes		0	By-catch	1	18000	
Kennebecasis			Regular			0	By-catch	1	2068	
Penobscot			Regular	Progression through age classes		0	Water Quality, Impinge/Entrain	2		
Kennebec	-1%		Regular	Progression through age classes		0	Water Quality, Impinge/Entrain	2	9500	
Androscoggin						0		0	3000	
Merrimack			Regular	Present		0		0	100	
Connecticut			Regular	Progression through age classes	Dams	1		0	1500	
Hudson	-1%		Regular	Progression through age classes		0	Water Quality, By-catch, Impinge/Entrain	3	61000	
Delaware	0%		Regular	Progression through age classes		0	Water Quality, Impinge/Entrain,	3	12000	
Potomac						0		0		
James						0		0		
Neuse			None	None		0		0		
Cape Fear			Intermittent	Present		0	Water Quality, Impinge/Entrain,	3	100	
Waccamaw/ Pee Dee						0		0		
Santee					Dams	1		0		
Cooper			Regular	Progression through age classes	Dams	1		0	200	
ACE Basin		89%	Regular	Progression through age classes		0	Water Quality, By-catch	2		
Savannah			Regular	Progression through age classes		0	Water Quality, By-catch, Impinge/Entrain, Dams	4	1675	
Ogeechee	0%		Intermittent	Present		0	Water Quality, By-catch	2	368	
Altamaha			Regular	Progression through age classes		0	Water Quality, By-catch	2	6320	
Satilla	-1%	84%	Intermittent	Present		0	Water Quality	1	100	
St. Mary's					Water Quality	1	By-catch	1		
St. John's						0		0		

[a]Data sources: (Bahr and Peterson 2016; Bahr and Peterson 2017; Bain et al. 2007; Bain et al. 1998; Cooke and Leach 2004; COSEWIC 2005); Dadswell (1979); (Fritts and Peterson 2011; Hastings et al. 1987; Kynard 1997; NMFS 1998; Oakley and Hightower 2007; Peterson and Bednarski 2013; Peterson and Farrae 2011; Savoy and Benway 2004; Squiers 2003; Squiers et al. 1993; SSSRT 2010)

Recovery Goals

The Shortnose Sturgeon Recovery Plan was developed in 1998. The long-term recovery objective, as stated in the Plan, is to recover all 19 discrete populations to levels of abundance at which they no longer require protection under the ESA (NMFS 1998). To achieve and preserve minimum population sizes for each population segment, essential habitats must be identified and maintained, and mortality must be monitored and minimized. Accordingly, other key recovery tasks discussed in the Plan are to define essential habitat characteristics, assess mortality factors, and protect shortnose sturgeon through applicable federal and state regulations.

4.2.3 Gulf of Maine Atlantic Salmon

Species Description

The Atlantic salmon is an anadromous fish, occupying freshwater streams in North America. There are three Atlantic salmon DPSs in the United States: Long Island Sound, Central New

England, and the GOM (Fay et al. 2006). The GOM DPS Atlantic salmon are found in watersheds throughout Maine as shown in Figure 6.

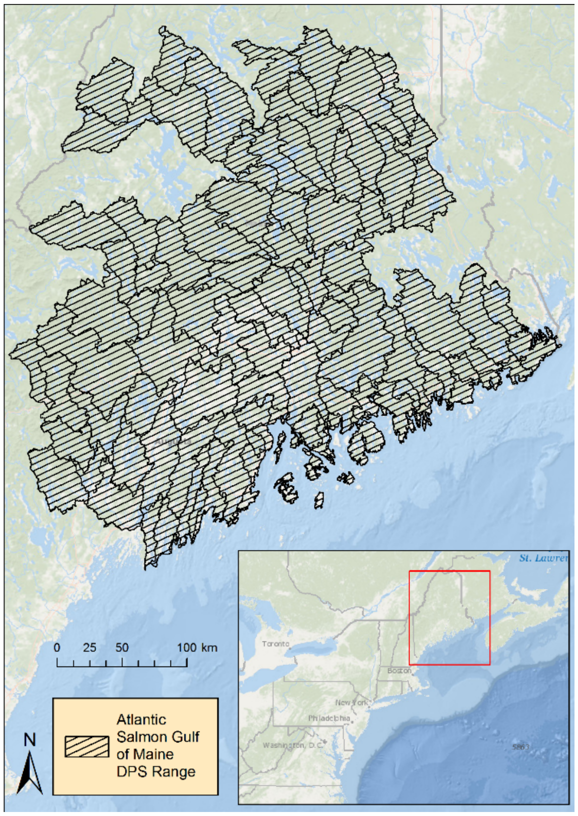

Figure 6. Map identifying the range of Gulf of Maine Atlantic salmon.

Adult Atlantic salmon are silver-blue with dark spots. They average 8-12 pounds but can get as large as 30 pounds. The GOM DPS was first listed as endangered by the U. S. Fish and Wildlife Service and NMFS on November 17, 2000 (65 FR 69459). The listing was refined by the Services on June 19, 2009, to include all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment.

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Salmo salar	Atlantic salmon	GOM	Endangered	2006	2009 74 FR 29344	Draft 2016	2009 74 FR 29300

We used information available in the status review (Fay et al. 2006) and recent scientific publications to summarize the life history, population dynamics and status of the species, as follows.

Life History

Atlantic salmon have a complex life history that ranges from territorial rearing in rivers to extensive feeding migrations on the high seas. Most adult Atlantic salmon ascend the rivers of New England beginning in the spring, continuing into the fall with the peak occurring in June. Adult Atlantic salmon typically spawn around early November and eggs hatch in late March or April. Preferred spawning habitat is a gravel substrate with adequate water circulation to keep the buried eggs well oxygenated. Juveniles spend about two years feeding in freshwater until they weigh approximately two ounces and are six inches in length. Smoltification (the physiological and behavioral changes required for the transition to salt water) usually occurs at age two for GOM DPS Atlantic salmon. GOM DPS Atlantic salmon migrate more than 4,000 km in the open ocean to reach feeding areas in the Davis Strait between Labrador and Greenland. The majority of GOM DPS Atlantic salmon (about ninety percent) spend two winters at sea before reaching maturity and returning to their natal rivers, with the remainder spending one or three winters at sea. At maturity, GOM DPS Atlantic salmon typically weigh between eight to fifteen pounds and average thirty inches in length. Atlantic salmon are iteroparous (i.e., capable of spawning more than once).

Population Dynamics

GOM DPS Atlantic salmon can be found in at least eight rivers in Maine: Dennys River, East Machias River, Machias River, Pleasant River, Narraguagus River, Ducktrap River, Sheepscot River, Cove Brook, Penobscot River, Androscoggin River and the Kennebec River. The GOM DPS Atlantic salmon is genetically distinct from other Atlantic salmon populations in Canada, and can be further delineated into stocks: Downeast Coastal stock which includes the Dennys, East Machias, Machias, Pleasant and Narraguagus Rivers; Penobscot Bay stock; and the Merrymeeting Bay (Sheepscot) stock. The hatchery supplementation programs for the Penobscot and Merrymeeting Bays stocks use river-specific broodstock (USASAC 2016). The conservation hatchery program plays a significant role in the persistence of GOM DPS Atlantic salmon. Adult returns of GOM DPS Atlantic salmon captured in six Maine rivers from 1997 to 2004 ranged from 567 to 1,402. These counts include both wild and hatchery origin fish. Each year, the majority (ninety-two to ninety-eight percent) of adult returns were found in the Penobscot River; the Narraguagus River supported between 0.8 to 4.1 percent of adult returns during those years (Fay et al. 2006). Estimated Atlantic salmon returns to U.S. rivers from 2005 to 2015 range from a low in 2014 of 450 to a high in 2011 of 4,178 (USASAC 2016). In 2015, four million juvenile salmon (eggs, fry, parr and smolts) and 4,271 adults were stocked in the Connecticut, Merrimack, Saco, Penobscot and five other coastal rivers in Maine (USASAC 2016). The total number of adult returns to U.S. rivers in 2015 was 921, the majority (eighty percent) of which were of hatchery origin. The fact that so few of the returning adults are naturally-reared is concerning to managers; the reliance on hatcheries can pose risks such as artificial selection, inbreeding depression and outbreeding depression (Fay et al. 2006). There is no population growth rate available for GOM DPS Atlantic salmon. However, the consensus is that the DPS exhibits a continuing declining trend (NOAA 2016).

Status

Historically, Atlantic salmon occupied U.S. rivers throughout New England, with an estimated 300,000 to 500,000 adults returning annually (Fay et al. 2006). Of the three DPSs found in the United States, native salmon in the Long Island Sound and Central New England DPSs were extirpated in the 1800s. Several rivers within these DPSs are presently stocked with GOM DPS salmon. The GOM DPS Atlantic salmon was listed as endangered in response to population decline caused by many factors, including overexploitation, degradation of water quality and damming of rivers, all of which remain persistent threats (Fay et al. 2006). Coastal development poses a threat as well, as artificial light can disrupt and delay fry dispersal (Riley et al. 2013). Climate change may cause changes in prey availability and thermal niches, further threatening Atlantic salmon populations (Mills et al. 2013). Even with current conservation efforts, returns of adult Atlantic salmon to the GOM DPS rivers remain extremely low, with an estimated extinction risk of nineteen to seventy-five percent in the next one hundred years (Fay et al. 2006). Based on the information above, the species would likely have a low resilience to additional perturbations.

Critical Habitat

See Section 4.1.4 for discussion of Atlantic salmon critical habitat within the action area.

Recovery Goals

See the 2016 Draft Recovery Plan for the GOM DPS Atlantic Salmon (USFWS and NMFS 2016), for complete down listing/delisting criteria for each of their respective recovery goals. Recovery actions identified in the Draft Recovery Plan include the following:

- Enhance connectivity between ocean and freshwater habitats important for recovery
- Maintain the genetic diversity of Atlantic salmon populations over time
- Increase adult spawners through the conservation hatchery program
- Increase Atlantic salmon survival through increased ecosystem understanding and identification of spatial and temporal constraints to salmon marine productivity to inform and support management actions that improve survival
- Consult with all involved Tribes on a government-to-government basis

- Collaborate with partners and engage interested parties in recovery efforts

4.2.4 Smalltooth Sawfish

Species Description

Although this species is reported to have a circumtropical distribution, NMFS identified smalltooth sawfish from the Southeast United States as a DPS. Within the U.S., smalltooth sawfish have been captured in estuarine and coastal waters from New York southward through Texas, although peninsular Florida has historically been the region of the United States with the largest number of recorded captures (NMFS 2010) (Figure 7).

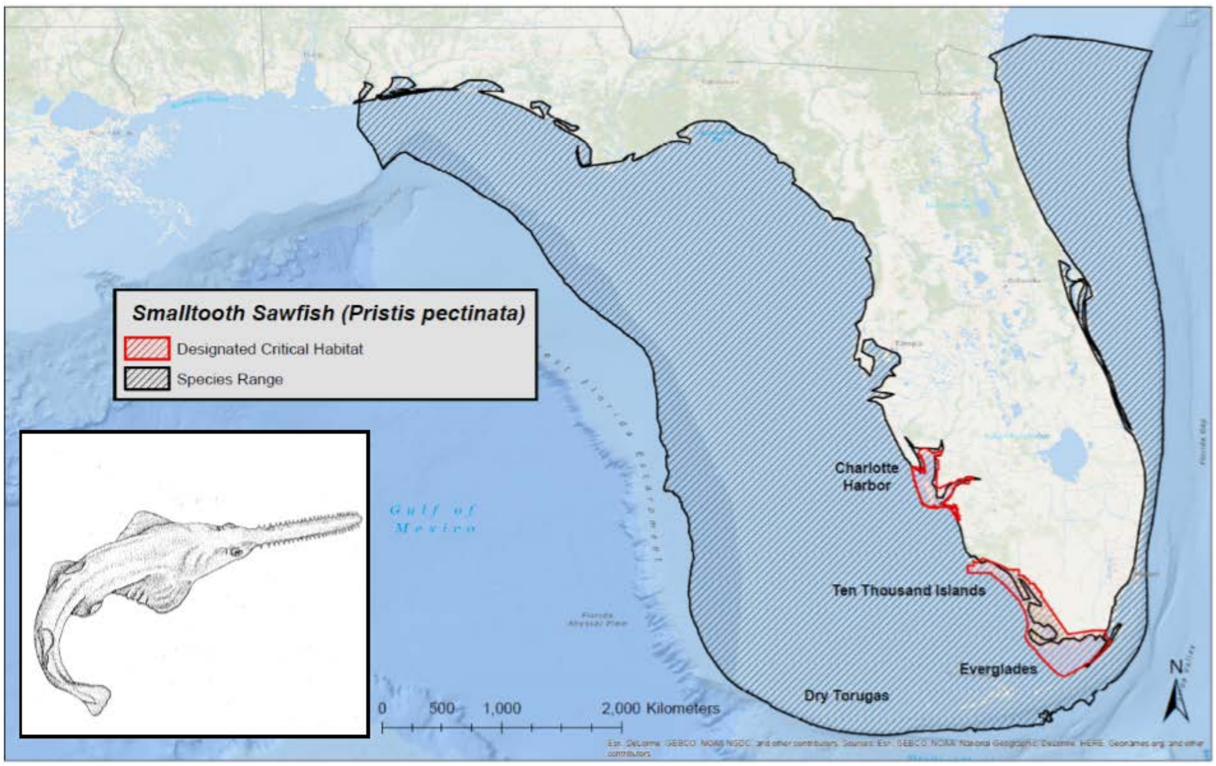

Figure 7. Smalltooth sawfish range and designated critical habitat.

The smalltooth sawfish (*Pristis pectinata*) is a tropical marine and estuarine elasmobranch. Although they are rays, sawfish physically resemble sharks, with only the trunk and especially the head ventrally flattened. Smalltooth sawfish are characterized by their "saw," a long, narrow, flattened rostral blade with a series of transverse teeth along either edge (NMFS 2009). The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA effective May 1, 2003.

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Pristis pectinata	Sawfish, smalltooth	US portion of range	Endangered	2010	2003 68 FR 15674	2009	2009 74 FR 45353

Life History

Smalltooth sawfish size at sexual maturity has been reported as 360 cm TL by Simpfendorfer (2005). Carlson and Simpfendorfer (2015) estimated that sexual maturity for females occurs between 7 and 11 years of age. As in all elasmobranchs, smalltooth sawfish are viviparous; fertilization is internal. The gestation period for smalltooth sawfish is estimated at 5 months based on data from the largetooth sawfish (Thorson 1976). Females move into shallow estuarine and nearshore nursery areas to give birth to live young between November and July, with peak parturition occurring between April and May (Poulakis et al. 2011). Litter sizes range between 10 and 20 individuals (Bigalow and Schroeder 1953; Carlson and Simpfendorfer 2015; Simpfendorfer 2005).

Neonate smalltooth sawfish are born measuring 67 – 81 cm TL and spend the majority of their time in the shallow nearshore edges of sand and mud banks (Poulakis et al. 2011; Simpfendorfer et al. 2010). Once individuals reach 100 – 140cm TL they begin to expand their foraging range. Capture data suggests smalltooth sawfish in this size class may move throughout rivers and estuaries within a salinity range of 18 and 30 (practical salinity units). Individuals in this size class also appear to have the highest affinity to mangrove habitat (Simpfendorfer et al. 2011). Juvenile sawfish spend the first 2-3 years of their lives in the shallow waters provided in the lower reaches of rivers, estuaries, and coastal bays (Simpfendorfer et al. 2008; Simpfendorfer et al. 2011). As smalltooth sawfish approach 250 cm TL they become less sensitive to salinity changes and begin to move out of the protected shallow-water embayments and into the shorelines of barrier islands (Poulakis et al. 2011). Adult sawfish typically occur in more open-water, marine habitats (Poulakis and Seitz 2004).

Population Dynamics

The abundance of smalltooth sawfish in U.S. waters has decreased dramatically over the past century. Efforts are currently underway to provide better estimates of smalltooth sawfish abundance (NMFS 2014). Current abundance estimates are based on encounter data, genetic sampling, and geographic extent. Carlson and Simpfendorfer (2015) used encounter densities to estimate the female population size to be 600. Chapman et al. (2011) analyzed genetic data from tissue samples (fin clips) to estimate the effective genetic population size as 250-350 adults (95 percent confidence interval from 142 to 955). Simpfendorfer (2002) estimated that the U.S. population may number less than five percent of historic levels based on the contraction of the species' range.

The abundance of juveniles encountered in recent studies (Poulakis et al. 2014; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004) suggests that the smalltooth sawfish population remains reproductively viable. The overall abundance appears to be stable (Wiley and Simpfendorfer 2010). Data analyzed from the Everglades portion of the smalltooth sawfish range suggests that the population growth rate for that region may be around five percent per year (Carlson and Osborne 2012; Carlson et al. 2007). Intrinsic rates of growth (λ) for smalltooth sawfish have been estimated at 1.08-1.14 per year and 1.237-1.150 per year by Simpfendorfer (2000) and Carlson and Simpfendorfer (2015) respectively. However, these intrinsic rates are uncertain due to the lack of long-term abundance data.

Chapman et al. (2011) investigated the genetic diversity within the smalltooth sawfish population. The study reported that the remnant population exhibits high genetic diversity (allelic richness, alleles per locus, heterozygosity) and that inbreeding is rare. The study also suggested that the protected population will likely retain > 90 percent of its current genetic diversity over the next century.

Recent capture and encounter data suggests that the current distribution is focused primarily to south and southwest Florida from Charlotte Harbor through the Dry Tortugas (Poulakis and Seitz 2004; Seitz and Poulakis 2002) (Figure 7). Water temperatures (no lower than 16-18°C) and the availability of appropriate coastal habitat (shallow, euryhaline waters and red mangroves) are the major environmental constraints limiting the distribution of smalltooth sawfish (Bigalow and Schroeder 1953).

Status

The decline in the abundance of smalltooth sawfish has been attributed to fishing (primarily commercial and recreational bycatch), habitat modification (including changes to freshwater flow regimes as a result of climate change), and life history characteristics (i.e. slow-growing, relatively late-maturing, and long-lived species) (NMFS 2009; Simpfendorfer et al. 2011). These factors continue to threaten the smalltooth sawfish population. Recent records indicate there is a resident reproducing population of smalltooth sawfish in south and southwest Florida from Charlotte Harbor through the Dry Tortugas, which is also the last U.S. stronghold for the species (Poulakis and Seitz 2004; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004). Recent information indicates the smalltooth sawfish population is likely stable or increasing (Carlson and Osborne 2012; Carlson and Simpfendorfer 2015). While the overall abundance appears to be stable, low intrinsic rates of population increase suggest that the species is particularly vulnerable to rapid population declines (NMFS 2010).

Designated Critical Habitat

Critical habitat for smalltooth sawfish was designated in 2009 and includes two major units: Charlotte Harbor (221,459 acres) and Ten Thousand Islands/Everglades (619,013 acres) (Figure 7). These two units include essential sawfish nursery areas. Within the nursery areas, two features were identified as essential to the conservation of the species: red mangroves (*Rhizophora mangle*), and euryhaline habitats with water depths ≤0.9 m. There is no overlap between the action area for this biological opinion and smalltooth sawfish designated critical habitat.

Recovery Goals

The 2009 Smalltooth Sawfish Recovery Plan (NMFS 2009) contains complete downlisting/delisting criteria for each of the three following recovery goals:

1. Minimize human interactions and associated injury and mortality.
   Specific criteria include: a) educational programs, b) handling and release guidelines, c) injury and mortality regulations, and d) other State and/or Federal measures (not including those provided under the ESA.
2. Protect and/or restore smalltooth sawfish habitats.
   Specific criteria include: a) protection of existing mangrove shoreline habitat, b) assurance of availability and accessibility of both mangrove and non-mangrove habitat sufficient to support subpopulations of juvenile sawfish, c) appropriate freshwater flow regimes, and d) identification and protection of habitat areas utilized by adult smalltooth sawfish.
3. Ensure smalltooth sawfish abundance increases substantially and the species reoccupies areas from which it had been previously extirpated.
   Specific criteria include: a) annual increases in the relative abundance of juvenile smalltooth sawfish, b) annual increases in the relative abundance of adult smalltooth sawfish, and c) verified records of adult smalltooth sawfish in outer regions of the species range.

4.2.5 North Atlantic Green Turtle

Species description

The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5°N, 77°W) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48°N, 77°W) in the north (Figure 8). The range of the

DPS then extends due east along latitudes 48°N and 19°N to the western coasts of Europe and Africa. The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 lbs. (159 kgs) and a straight carapace length of greater than 3.3 feet (1 meter).

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Chelonia mydas	*Green Turtle*	*North Atlantic* *(4 sub-populations)*	*Threatened*	*2015*	*81 FR 20057*	*1991*	*63 FR 46693*

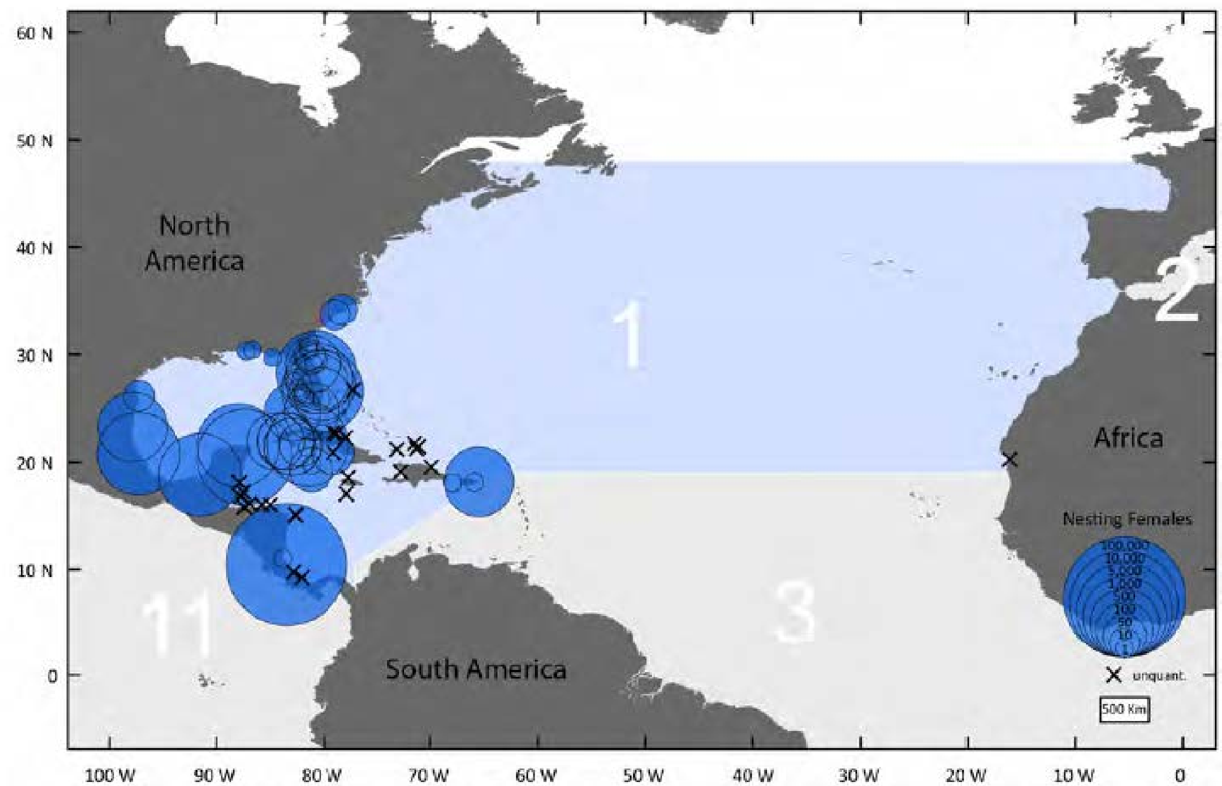

Figure 8. Geographic range of the North Atlantic green sea turtle, with location and abundance of nesting females. From (Seminoff et al. 2015).

The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed 11 DPSs of green sea turtles as threatened or endangered under the ESA. The North Atlantic DPS is listed as threatened. We used information available in the 2007 Five Year

Review (USFWS 2007) and 2015 Status Review (Seminoff et al. 2015) to summarize the life history, population dynamics and status of the species, as follows.

Life history

Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the North Atlantic DPS green sea turtle.

Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at seventy-three nesting sites, and available data indicate an increasing trend in nesting. The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts seventy-nine percent of nesting females for the DPS (Seminoff et al. 2015).

For the North Atlantic DPS, the available data indicate an increasing trend in nesting. There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. Modeling by Chaloupka et al. (2008) using data sets of twenty-five years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9 percent, and the Tortuguero, Costa Rica, population growing at 4.9 percent.

The North Atlantic DPS has a globally unique haplotype, which was a factor in defining the discreteness of the population for the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting subpopulations in Florida, Cuba, Mexico and

Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016).

Status

Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population's decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green sea turtle generation, up to fifty years. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS appears to be somewhat resilient to future perturbations.

The estimated total green turtle nesting female abundance for Florida is 8,426 turtles (Seminoff et al. 2015). A Population Viability Analysis was conducted for the Florida population based on an index of adult female nesters from 1989 to 2012. Nesting beach monitoring data and the Population Viability Analysis indicate that there is a 0.3 percent probability that this population will fall below the trend reference point (50 percent decline) at the end of 100 years, and a 0 percent probability that this population will fall below the absolute abundance reference (100 females per year) at the end of 100 years (Seminoff et al. 2015).

Critical Habitat

On September 2, 1998, NMFS designated critical habitat for green sea turtles, which include coastal waters surrounding Culebra Island, Puerto Rico. Seagrass beds surrounding Culebra provide important foraging resources for juvenile, subadult and adult green sea turtles. Additionally, coral reefs surrounding the island provide resting shelter and protection from predators. There is no overlap between the action area for this biological opinion and green turtle designated critical habitat.

Recovery Goals

Recovery plan goals for green sea turtles emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics. See the 1998 recovery plan for the Pacific (NMFS and USFWS 1998a) and 1991 recovery plan for the Atlantic (NMFS and USFWS 1991) populations of green turtles for complete down-listing/delisting criteria for recovery goals for the species.

4.2.6 Hawksbill Turtle

Species Description

The hawksbill turtle has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical oceans (Figure 9). The hawksbill sea turtle has a sharp, curved, beak-like mouth and a “tortoiseshell” pattern on its carapace, with radiating streaks of brown, black, and amber. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973.

We used information available in the five year reviews (NMFS 2013a; NMFS and USFWS 2007a) to summarize the life history, population dynamics and status of the species, as follows.

Life History

Hawksbill sea turtles reach sexual maturity at twenty to forty years of age. Females return to their natal beaches every two to five years to nest and nest an average of three to five times per season. Clutch sizes are large (up to 250 eggs). Sex determination is temperature dependent, with warmer incubation producing more females. Hatchlings migrate to and remain in pelagic habitats until they reach approximately twenty two to twenty five centimeters in straight carapace length.

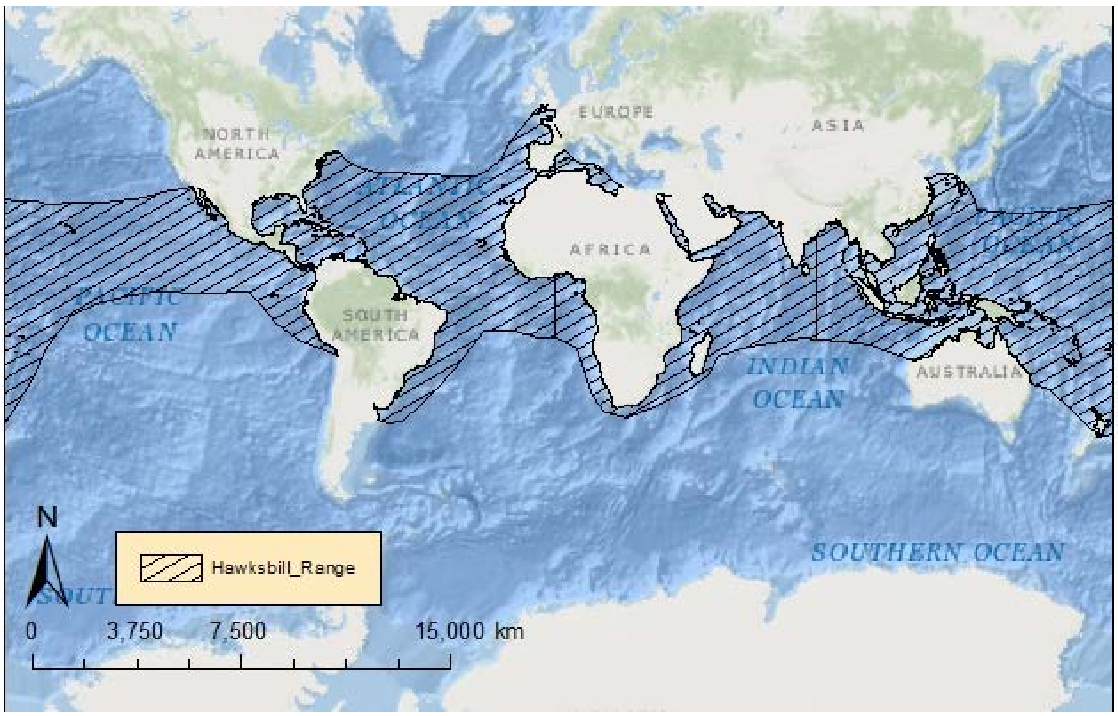

Figure 9. Map identifying the range of the endangered hawksbill turtle.

Juvenile hawksbills take up residency in coastal waters to forage and grow. Adults use their sharp, beak-like mouths to feed on sponges and corals. Hawksbill sea turtles are highly migratory and use a wide range of habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Satellite tagged turtles have shown significant variation in movement and migration patterns. Distance traveled between nesting and foraging locations ranges from a few hundred to a few thousand kilometers (Horrocks et al. 2001; Miller et al. 1998).

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Eretmochelys imbricata	*Hawksbill turtle*	*None designated*	*Endangered range wide*	*2013*	*1970* *35 FR 8491*	*1992* *57 FR 38818*	*1998* *63 FR 46693*

Population Dynamics

Surveys at eighty eight nesting sites worldwide indicate that 22,004 to 29,035 females nest annually (NMFS 2013a). In general, hawksbills are doing better in the Atlantic and Indian Ocean than in the Pacific Ocean, where despite greater overall abundance, a greater proportion of the nesting sites are declining. From 1980 to 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased fifteen percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS 2013a).

Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. Genetic analysis of hawksbill sea turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the western Atlantic, where the vast majority of nesting has been documented (McClellan et al. 2010; Monzon-Arguello et al. 2010). Hawksbills in the Caribbean seem to have dispersed into separate populations (rookeries) after a bottleneck roughly 100,000 to 300,000 years ago (Leroux et al. 2012).

The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific Oceans. In their oceanic phase, juvenile hawksbills can be found in *Sargassum* mats; post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, seagrass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997).

Status

Long-term data on the hawksbill sea turtle indicate that sixty-three sites have declined over the past twenty to one hundred years (historic trends are unknown for the remaining twenty-five sites). Recently, twenty-eight sites (sixty-eight percent) have experienced nesting declines, ten have experienced increases, three have remained stable, and forty-seven have unknown trends. Regarding regional trends, nesting populations in the Atlantic (especially in the Insular Caribbean and Western Caribbean Mainland) are generally doing better than those in the Indo-

Pacific regions (e.g., 9 of the 10 sites showing recent increases were all located in the Caribbean). Surveys of Mona Island, Puerto Rico, nesting beaches indicate an increasing population trend spanning the past three decades. The greatest threats to hawksbill sea turtles are overharvesting of turtles and eggs, degradation of nesting habitat, and fisheries interactions. Adult hawksbills are harvested for their meat and carapace, which is sold as tortoiseshell. Eggs are taken at high levels, especially in southeast Asia where collection approaches one hundred percent in some areas. In addition, lights on or adjacent to nesting beaches are often fatal to emerging hatchlings and alters the behavior of nesting adults. The species' resilience to additional perturbation is low.

Critical Habitat

On September 2, 1998, NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico. Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey. There is no overlap between the action area for this biological opinion and hawksbill turtle designated critical habitat.

Recovery Goals

See the 1993 Recovery Plan for the U.S. Caribbean, Atlantic and Gulf of Mexico (NMFS and USFWS 1993) and the 1998 Recovery Plan for the U.S. Pacific populations (NMFS and USFWS 1998b) of hawksbill sea turtles, respectively, for complete down listing/delisting criteria for each of their respective recovery goals. Recovery actions identified in hawksbill recovery plans included:

- Identify important nesting beaches
- Ensure long-term protection and management of important nesting beaches
- Protect and manage nesting habitat; prevent the degradation of nesting habitat caused by seawalls, revetments, sand bags, other erosion-control measures, jetties and breakwaters
- Identify important marine habitats; protect and manage populations in marine habitat
- Protect and manage marine habitat; prevent the degradation or destruction of important marine habitats caused by upland and coastal erosion
- Prevent the degradation of reef habitat caused by sewage and other pollutants
- Monitor nesting activity on important nesting beaches with standardized index surveys
- Evaluate nest success and implement appropriate nest-protection on important nesting beaches
- Ensure that law-enforcement activities prevent the illegal exploitation and harassment of sea turtles and increase law-enforcement efforts to reduce illegal exploitation
- Determine nesting beach origins for juveniles and subadult populations

4.2.7 Kemp's Ridley Turtle

Species Description

The Kemp's ridley turtle is considered the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). Its range extends from the Gulf of Mexico to the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas (Figure 10).

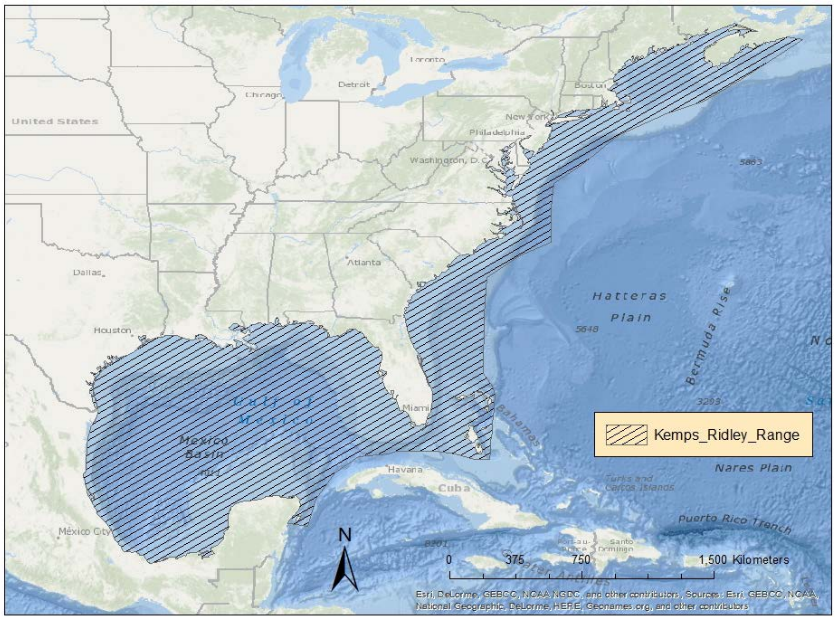

Figure 10. Map identifying the range of the endangered Kemp's ridley sea turtle.

Kemp's ridley sea turtles the smallest of all sea turtle species, with a nearly circular top shell and a pale yellowish bottom shell. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973.

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Lepidochelys kempii	*Kemp's ridley turtle*	*None Designated*	*Endangered range wide*	*2015*	*1970* *35 FR 18319*	*2010* *75 FR 12496*	*None Designated*

We used information available in the revised recovery plan (NMFS and USFWS 2011) and the Five-Year Review (NMFS and USWFS 2015) to summarize the life history, population dynamics and status of the species, as follows.

Life History

Females mature at twelve years of age. The average remigration is two years. Nesting occurs from April to July in large arribadas, primarily at Rancho Nuevo, Mexico. Females lay an average of 2.5 clutches per season. The annual average clutch size is ninety-seven to one hundred eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately two years before returning to nearshore coastal habitats. Juvenile Kemp’s ridley sea turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic Coast) as water temperatures drop. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 m) deep, although they can also be found in deeper offshore waters. Adult Kemp’s ridleys forage on swimming crabs, fish, jellyfish, mollusks, and tunicates (NMFS and USFWS 2011).

Population Dynamics

Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from three primary nesting beaches in Mexico (NMFS and USWFS 2015). The number of nests in Padre Island, Texas has increased over the past two decades, with one nest observed in 1985, 4 in 1995, 50 in 2005, 197 in 2009, and 119 in 2014 (NMFS and USWFS 2015).

From 1980 to 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased fifteen percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USWFS 2015).

Genetic variability in Kemp’s ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS and USFWS 2011). Additional analysis of the mitochondrial DNA taken from samples of Kemp’s ridley turtles at Padre Island, Texas, showed six distinct haplotypes, with one found at both Padre Island and Rancho Nuevo (Dutton et al. 2006).

The Kemp's ridley occurs from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000). Kemp’s ridley sea turtles have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico. During spring and summer, juvenile Kemp's ridleys occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida. In the fall, most Kemp's ridleys migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2010b).

Status

The Kemp's ridley was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May to August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a sanctuary. A successful head-start program has resulted in the reestablishment of nesting at Texan beaches. While fisheries bycatch remains a threat, the use of turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species.

Following the 2010 Deepwater Horizon oil spill, unprecedented numbers of Kemp's ridley sea turtles stranded on northern Gulf of Mexico beaches and the number of nests recorded on the primary nesting beaches plummeted far below expected levels (Gallaway et al. 2016). High levels of strandings have continued since 2010. The number of nests recovered to approximately 2009 levels in 2011, improved slightly in 2012 before declining sharply in 2013 (Gallaway et al. 2016). Gallaway et al. (2016) suggest that reduced prey resources coupled with an increase in the number of Kemp's ridleys might be sufficient to change the remigration interval or the number of nests or eggs produced within a year. This provides a possible explanation for the recent (2013 and 2014) reductions in the number of nests, which have been far below what was predicted.

It is clear that the Kemp's ridley population shows a steadily increasing long-term trend; however, the species' limited range and low global abundance make it vulnerable to new sources of mortality (i.e., oil spills) as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

Recovery Goals

See the 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley sea turtles (NMFS et al. 2010a) for complete down listing/delisting criteria for each of their respective recovery goals. The following items were identified as recovery priorities:

- Protect and manage nesting and marine habitats
- Protect and manage populations on the nesting beaches and in the marine environment

- Maintain a stranding network
- Manage captive stocks
- Sustain education and partnership programs
- Maintain, promote awareness of and expand U.S. and Mexican laws
- Implement international agreements
- Enforce laws

4.2.8 Leatherback Turtle

Species Description

The leatherback sea turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to subpolar latitudes, worldwide (Figure 11). Leatherbacks are the largest living turtle, reaching lengths of six feet long, and weighing up to one ton. Leatherback sea turtles have a distinct black leathery skin covering their carapace with pinkish white skin on their belly. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973.

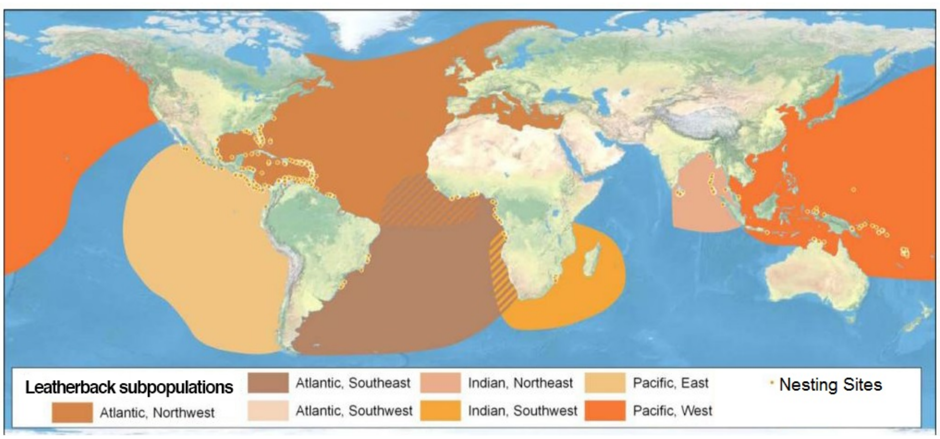

Figure 11. Map identifying the range of the endangered leatherback sea turtle. Adapted from (Wallace 2013).

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Dermochelys coriacea	*Leatherback sea turtle*	*None Designated*	*Endan-gered range wide*	*2013*	*1970* *35 FR 8491*	*1992* *63 FR 28359*	*1979 and 2012* *44 FR 17710 and 77 FR 4170*

We used information available in the five-year review (NMFS 2007) and the critical habitat designation to summarize the life history, population dynamics and status of the species, as follows.

Life History

Age at maturity has been difficult to ascertain, with estimates ranging from five to twenty-nine years (Avens et al. 2009; Spotila et al. 1996). Females lay up to seven clutches per season, with more than sixty-five eggs per clutch and eggs weighing greater than 80 g (Reina et al. 2002; Wallace et al. 2007). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately fifty percent worldwide (Eckert et al. 2012). Females nest every one to seven years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight. Leatherbacks weigh about thirty-three percent more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James et al. 2005; Wallace et al. 2006). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals (the time between nesting) are dependent upon foraging success and duration (Hays 2000; Price et al. 2004).

Population Dynamics

Leatherbacks are globally distributed, with nesting beaches in the Pacific, Atlantic, and Indian oceans. Detailed population structure is unknown, but is likely dependent upon nesting beach location. Based on estimates calculated from nest count data, there are between 34,000 and 94,000 adult leatherbacks in the North Atlantic (TEWG 2007). In contrast, leatherback populations in the Pacific are much lower. Overall, Pacific populations have declined from an estimated 81,000 individuals to less than 3,000 total adults and subadults (Spotila et al. 2000).

Population abundance in the Indian Ocean is difficult to assess due to lack of data and inconsistent reporting. Available data from southern Mozambique show that approximately ten females nest per year from 1994 to 2004, and about 296 nests per year counted in South Africa (NMFS 2013b).

Population growth rates for leatherback sea turtles vary by ocean basin. Counts of leatherbacks at nesting beaches in the western Pacific indicate that the subpopulation has been declining at a rate of almost six percent per year since 1984 (Tapilatu et al. 2013). Leatherback subpopulations in the Atlantic Ocean, however, are showing signs of improvement. Nesting females in South Africa are increasing at an annual rate of four to 5.6 percent, and from nine to thirteen percent in Florida and the U.S. Virgin Islands (TEWG 2007), believed to be a result of conservation efforts.

Analyses of mitochondrial DNA from leatherback sea turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the Atlantic and Indian oceans suggest that each of the rookeries represent demographically independent populations (NMFS 2013b).

Leatherback sea turtles are distributed in oceans throughout the world (Figure 11). Leatherbacks occur throughout marine waters, from nearshore habitats to oceanic environments (Shoop and Kenney 1992). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011).

Status

The leatherback sea turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The primary threats to leatherback sea turtles include fisheries bycatch, harvest of nesting females, and egg harvesting. Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, and sand extraction. Lights on or adjacent to nesting beaches alter nesting adult behavior and are often fatal to emerging hatchlings as they are drawn to light sources and away from the sea. Plastic ingestion is common in leatherbacks and can block gastrointestinal tracts leading to death. Climate change may alter sex ratios (as temperature determines hatchling sex), range (through expansion of foraging habitat), and habitat (through the loss of nesting beaches, due to sea-level rise. The species' resilience to additional perturbation is low.

Populations in the eastern Atlantic (i.e., off Africa) and Caribbean appear to be stable; however, information regarding the status of the entire leatherback population in the Atlantic is lacking and it is certain that some nesting populations (e.g., St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS 2007b).

Critical Habitat

On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, Virgin Islands from the 183 meter isobath to mean high tide level between 17° 42’12” N and 65°50’00” W. This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity; however, studies do not support significant critical habitat deterioration.

On January 20, 2012, NMFS issued a final rule to designate additional critical habitat for the leatherback sea turtle (50 CFR 226). This designation includes approximately 43,798 km^2 stretching along the California coast from Point Arena to Point Arguello east of the 3000 m depth contour; and 64,760 km^2 stretching from Cape Flattery, Washington, to Cape Blanco, Oregon, east of the 2,000 meter depth contour.

There is no overlap between the action area for this biological opinion and hawksbill turtle designated critical habitat.

Recovery Goals

See the 1992 Recovery Plan for the U.S Caribbean, Gulf of Mexico and Atlantic leatherback sea turtle (NMFS and USFWS 1992) for complete down listing/delisting criteria for each of their respective recovery goals. The following items were the top five recovery actions identified in the Leatherback Five Year Action Plan:

- Reduce fisheries interactions
- Improve nesting beach protection and increase reproductive output
- International cooperation
- Monitoring and research
- Public engagement

4.2.9 Northwest Atlantic Loggerhead Turtle

Species Description

Loggerhead sea turtles are circumglobal, and are found in the temperate and tropical regions of the Indian, Pacific and Atlantic Oceans (Figure 12). The loggerhead sea turtle is distinguished from other turtles by its reddish-brown carapace, large head and powerful jaws. The species was first listed as threatened under the ESA in 1978. On September 22, 2011, the NMFS designated nine DPSs of loggerhead sea turtles, with the Northwest Atlantic Ocean DPS listed as endangered.

We used information available in the 2009 Status Review (Conant et al. 2009) and the final listing rule to summarize the life history, population dynamics and status of the species, as follows.

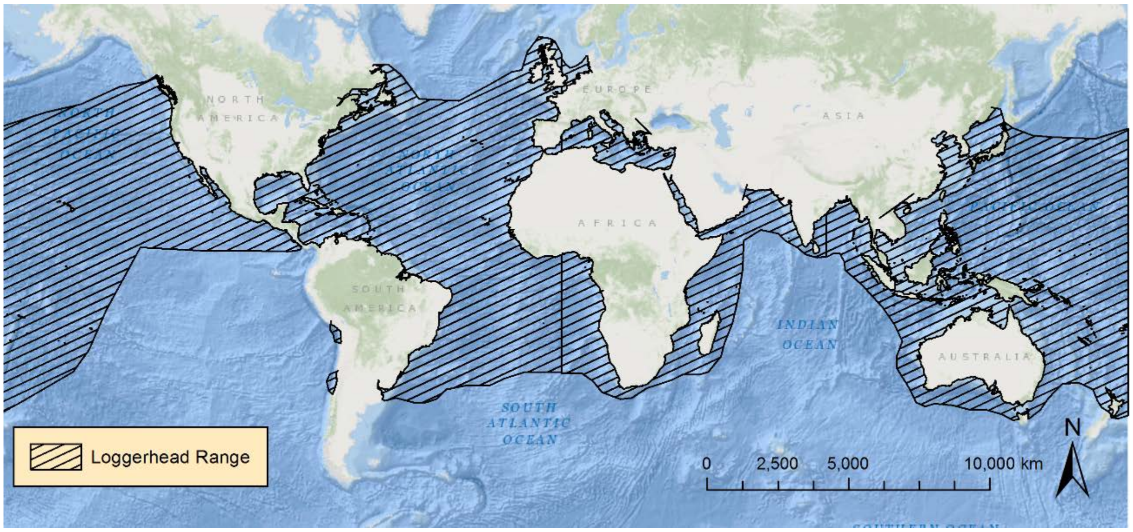

Figure 12. Map identifying the range of the loggerhead sea turtle.

Life History

Mean age at first reproduction for female loggerhead sea turtles is thirty years. Females lay an average of three clutches per season. The annual average clutch size is 112 eggs per nest. The average remigration interval is 2.7 years. Nesting occurs on beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the turtle during the middle of the incubation period. Turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone and later in the neritic zone (i.e., coastal waters). Coastal waters provide important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerheads.

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Caretta caretta	*Loggerhead sea turtle*	*Northwest Atlantic Ocean*	*Threatened*	*2009*	*2011* *76 FR 58868*	*2009* *74 FR 2995*	*2014* *79 FR 39855*

Population Dynamics

Using a stage/age demographic model, the adult female population size of the DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS-SEFSC 2009). Based on genetic information, the Northwest Atlantic Ocean DPS is further categorized into five recovery units corresponding to nesting beaches: Northern Recovery Unit; Peninsular Florida Recovery Unit; Dry Tortugas Recovery Unit; Northern Gulf of Mexico Recovery Unit; and the Greater Caribbean Recovery Unit. The Northern Recovery Unit, from North Carolina to northeastern Florida, and is the second largest nesting aggregation in the DPS, with an average of 5,215 nests from 1989 to 2008, and approximately 1,272 nesting females (NMFS and USFWS 2008). The Peninsular Florida Recovery Unit hosts more than 10,000 females nesting annually, which constitutes eighty-seven percent of all nesting effort in the DPS (Ehrhart et al. 2003). The Greater Caribbean Recovery Unit encompasses nesting subpopulations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903 to 2,331 nests annually (Zurita et al. 2003). Other significant nesting sites are found throughout the Caribbean, and including Cuba, with approximately 250 to 300 nests annually (Ehrhart et al. 2003), and over one hundred nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008). The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. The only available data for the nesting subpopulation on Key West comes from a census conducted from 1995 to 2004 (excluding 2002), which provided a mean of 246 nests per year, or about sixty nesting females (NMFS and USFWS 2007b). The Gulf of Mexico Recovery Unit has between one hundred to 999 nesting females annually, and a mean of 910 nests per year.

The population growth rate for each of the four of the recovery units for the Northwest Atlantic DPS (Peninsular Florida, Northern, Northern Gulf of Mexico, and Greater Caribbean) all exhibit negative growth rates (Conant et al. 2009). Nest counts taken at index beaches in Peninsular Florida show a significant decline in loggerhead nesting from 1989 to 2006, most likely attributed to mortality of oceanic-stage loggerheads caused by fisheries bycatch (Witherington et al. 2009). Loggerhead nesting on the Archie Carr National Wildlife Refuge (representing individuals of the Peninsular Florida subpopulation) has fluctuated over the past few decades. There was an average of 9,300 nests throughout the 1980s, with the number of nests increasing into the 1990s until it reached an all-time high in 1998, with 17,629 nests. From that point, the number of loggerhead nests at the Refuge have declined steeply to a low of 6,405 in 2007, increasing again to 15,539, still a lower number of nests than in 1998 (Bagley et al. 2013). For the Northern recovery unit, nest counts at loggerhead nesting beaches in North Carolina, South Carolina and Georgia declined at 1.9 percent annually from 1983 to 2005 (NMFS and USFWS 2007b). The nesting subpopulation in the Florida panhandle has exhibited a significant declining trend from 1995 to 2005 (Conant et al. 2009; NMFS and USFWS 2007b). Recent model estimates predict an overall population decline of seventeen percent for the St. Joseph Peninsula, Florida subpopulation of the Northern Gulf of Mexico recovery unit (Lamont et al. 2014).

Based on genetic analysis of nesting subpopulations, the Northwest Atlantic Ocean DPS is further divided into five recovery units: Northern, Peninsular Florida, Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean (Conant et al. 2009). A more recent analysis using expanded mitochondrial DNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct, and that rookeries from Mexico's Caribbean coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS should be considered as ten management units: (1) South Carolina and Georgia; (2) central eastern Florida; (3) southeastern Florida; (4) Cay Sal, Bahamas; (5) Dry Tortugas, Florida; (6) southwestern Cuba; (7) Quintana Roo, Mexico; (8) southwestern Florida; (9) central western Florida; and (10) northwestern Florida (Shamblin et al. 2012).

Loggerhead hatchlings from the western Atlantic disperse widely, most likely using the Gulf Stream to drift throughout the Atlantic Ocean. Mitochondrial DNA evidence demonstrates that juvenile loggerheads from southern Florida nesting beaches comprise the vast majority (seventy-one to eighty-eight percent) of individuals found in foraging grounds throughout the western and eastern Atlantic: Nicaragua, Panama, Azores and Madiera, Canary Islands and Adalusia, Gulf of Mexico and Brazil (Masuda 2010).

Status

Due to declines in nest counts at index beaches in the United States and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS is at risk and likely to decline in the foreseeable future (Conant et al. 2009). Bycatch data from the southeastern United States (central North Carolina through central Florida) indicate a possible increase in the abundance of neritic loggerheads in this region over the past one to two decades. However, this increase in catch rates for the southeastern United States was not consistent with the declining trend in nesting seen over the same period. Aerial surveys and one in-water study conducted in the northeastern United States (north of Cape Hatteras,North Carolina) also indicate a decrease in abundance in recent years (TEWG 2009).

The 2010 Deepwater Horizon oil spill negatively affected sea turtle nesting directly (e.g. adverse effects of oil exposure) and indirectly (e.g. beach cleanup activities deterring nesting) (Lauritsen et al. 2017). Loggerhead nest densities on northwest Florida beaches in 2010 were reduced by 43.7 percent (95 percent confidence interval: 10 to 65 percent) relative to expected nesting rates in the absence the oil spill and cleanup efforts (Lauritsen et al. 2017).

Critical Habitat

On July 10, 2014, NMFS and USFWS designated critical habitat for the Northwest Atlantic Ocean DPS loggerhead sea turtles along the U.S. Atlantic and Gulf of Mexico coasts from North Carolina to Mississippi. These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. See Section 4.1.3 for a more detailed discussion of loggerhead critical habitat within the action area.

Recovery Goals

See the 2008 Final Recovery Plan for the Northwest Atlantic DPS of loggerhead sea turtles (NMFS and USFWS 2008) for recovery objectives and complete down listing/delisting criteria.

5 ENVIRONMENTAL BASELINE

The “environmental baseline” includes the past and present impacts of all Federal, state, 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. This section is divided into two parts: (1) an overview of several past and ongoing anthropogenic threats to ESA-listed species within the action area, and (2) a brief description and characterization of the major regional drainages within the action area, including their general ecology, natural history, human activities, and environmental impacts. We focus our discussion of the environmental baseline on threats to all ESA-listed species in those areas where sturgeon research primarily occurs (i.e., streams, rivers, riparian areas and estuaries), with a particular emphasis on threats affecting Atlantic and shortnose sturgeon.

5.1 Anthropogenic Threats to Endangered Species Act Listed Species

The U.S. Atlantic coast has undergone significant physical, biological, and ecological changes over the past few centuries. These changes are primarily the result of human population growth and associated activities that have drastically altered the natural environment in this region. This section provides an overview of several past and ongoing anthropogenic threats to ESA-listed species within the action area.

5.1.1 Population Density, Development, and Land Use Changes

Many stream, riparian, and coastal areas within the action area have been degraded by the effects of land and water use associated with urbanization, road construction, forest management, agriculture, mining, transportation, water development, and other human activities. Development activities contribute to a variety of interrelated factors that lead to the decline of sturgeon and other ESA-listed species considered in this opinion. These include reduced in-channel and off-channel habitat, restricted lateral channel movement, increased flow velocities, increased erosion, decreased cover, reduced prey sources, increased contaminants, increased water temperatures, degraded water quality, and decreased water quantity.

Urbanization and increased human population density within a watershed result in changes in stream habitat, water chemistry, and the biota (plants and animals) that live there. In many cases, these changes negatively impact species, particularly those with small population sizes like the ESA-listed species within the action area. The most obvious effect of urbanization is the loss of natural vegetation, which results in an increase in impervious cover and dramatic changes to the natural hydrology of urban and suburban streams. Urbanization generally results in land clearing, soil compaction, modification and/or loss of riparian buffers, and modifications to natural drainage features. The increased impervious cover in urban areas leads to increased volumes of runoff, increased peak flows and flow duration, and greater stream velocity during storm events.

Runoff from urban areas also contains chemical pollutants from vehicles and roads, industrial sources, and residential sources. Urban runoff is typically warmer than receiving waters and can significantly increase temperatures, particularly in smaller streams. Municipal wastewater treatment plants replace septic systems, resulting in point discharges of nutrients and other contaminants not removed in the processing. Municipalities with combined sewer/stormwater overflows or older treatment systems may directly discharge untreated sewage following heavy rainstorms. Urban and suburban nonpoint and point source discharges affect water quality and quantity in basin surface waters. Dikes and levees constructed to protect infrastructure and agriculture have isolated floodplains from their river channels and restricted fish access. The many miles of roads and rail lines that parallel streams within the action area have degraded stream bank conditions and decreased floodplain connectivity by adding fill to floodplains. Culvert and bridge stream crossings have similar effects and create additional problems for fish when they act as physical or hydraulic barriers that prevent fish access to spawning or rearing habitat, or contribute to adverse stream morphological changes upstream and downstream of the crossing itself.

The Northeastern coastal zone covers approximately 37,158 km^2 in eight states (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey). Some of the highest population densities in the United States are found in coastal counties within this zone from Massachusetts through New Jersey (U.S. Census Bureau, www.census.gov). Primary land-cover classes are forests and developed land, which account for more than 70 percent of the ecoregion. Water, wetlands, and agriculture are secondary land cover classes found in smaller, less frequent concentrations in the Northeast coastal zone. Developed land increased an estimated 4 percent (1,510 km^2) from 1973 to 2000, to approximately 27 percent of the ecoregion's area (USGS 2017). Much of the new development came from forest loss, with a decrease of 3.7 percent (1,361 km^2) during this same period. Agricultural land-cover decreased by 0.8 percent. Other land cover changes in the Northeastern coastal zone from 1973 to 2000 included slight decreases in wetlands and slight increases in mechanically disturbed lands and mining (USGS Land Cover Trends Project). Increased development was the primary reason for these changes (i.e., wetlands converted to development, increased aggregate mining for construction materials, and forest land being cleared—mechanically disturbed—for pending development).

The Middle Atlantic coastal plain ecoregion covers approximately 89,691 km^2 that stretches from Delaware Bay and the Delmarva Peninsula in the north to Jacksonville, Florida (USGS Land Cover Trends Project). Portions of nine states are included in this ecoregion: New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida. Coastal states from Virginia through Florida experienced much faster population growth (14.3 percent) from 2000 to 2010 compared to Northeastern states from Maryland through Maine (3.2 percent) (U.S. Census Bureau, www.census.gov). The topography of the ecoregion is primarily flat, and many soil types are poorly drained. The dominant land uses within the Middle Atlantic coastal plain are farming and forestry, with urban development being locally significant. The land cover is primarily a mosaic of forest, wetlands, and agriculture cropland (i.e., soybeans, cotton, tobacco, soybeans and corn). Livestock production is most pronounced as confined animal feeding operations, such as for hogs in North Carolina and poultry on the Delmarva Peninsula (USDA 1999). Wetlands are common across the ecoregion and include coastal marshes, bottomland hardwood forests, and shrub bogs. Two of the Middle Atlantic Coastal Plain's dominant land covers, forest and wetlands, experienced net loss in coverage from 1973 and 2000 of -3.3 and -1.3 percent, respectively). The Middle Atlantic coastal plain ecoregion gained an estimated 2,247 km^2 of new developed land from 1973-2000 representing an increase of 2.6 percent. The majority of the newly developed land came from forestland (1,747 km^2), with much small amounts of agricultural land (253 km^2) and wetlands (134 km^2) being converted for development.

Coastal development can deter or interfere with sea turtle nesting, affect nest success, and degrade nesting habitat. Many nesting beaches have already been significantly degraded or destroyed. Nesting habitat is threatened by rigid shoreline protection or "coastal armoring" such as sea walls, rock revetments, and sandbag installations. Many miles of once productive nesting beach have been permanently lost to this type of shoreline protection. Nesting habitat can be also reduced by beach nourishment projects, which result in altered beach and sand characteristics, affecting nesting activity and success. In some areas, timber and marine debris accumulation as well as sand mining reduce available nesting habitat (Bourgeois et al. 2009). Hawksbill turtles prefer to nest under vegetation and are, therefore, particularly affected by beachfront development and clearing of dune vegetation (Mortimer and Donnelly 2007). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the sea (Witherington 1992).

In summary, the negative effects of population growth, development and land use changes on ESA-listed species within the action area are widespread and have continued to increase over time. Stressors associated with these activities will continue to hinder species recovery efforts.

5.1.2 Dams

Dams are used to impound water for water resource projects such as hydropower generation, irrigation, navigation, flood control, industrial and municipal water supply, and recreation. Dams can also have profound effects on anadromous species by fragmenting populations, impeding access to spawning and foraging habitat, and altering natural river hydrology and geomorphology, water temperature regimes, and sediment and debris transport processes (Pejchar and Warner 2001; Wheaton et al. 2004). The loss of historic habitat ultimately affects anadromous fish in two ways: 1) it forces fish to spawn in sub-optimal habitats that can lead to reduced reproductive success and recruitment, and 2) it reduces the carrying capacity (physically) of these species and affects the overall health of the ecosystem (Patrick 2005). Physical injury and direct mortality occurs as fish pass through turbines, bypasses, and spillways. Indirect effects of passage through all routes may include disorientation, stress, delay in passage, exposure to high concentrations of dissolved gases, elevated water temperatures, and increased vulnerability to predation. Activities associated with dam maintenance, such as dredging and minor excavations along the shore, can release silt and other fine river sediments that can be deposited in nearby spawning habitat. Dams can also reduce habitat diversity by forming a series of homogeneous reservoirs; these changes generally favor different predators, competitors and prey, than were historically present in the system (Auer 1996).

The detrimental effects of dams on populations of shortnose and Atlantic sturgeon are generally well documented (Cooke and Leach 2004; Kynard 1998). Perhaps the biggest impact dams have on sturgeon is the loss of upriver spawning and rearing habitat (Table 14). Migrations of sturgeon in rivers without barriers are wide-ranging with total distances exceeding 200 km or more, depending on the river system (Kynard 1997). Although some rivers have dams constructed at the fall line that have not impacted sturgeon spawning, in many other rivers dams have blocked sturgeon upriver passage, restricting spawning activities to areas below the impoundment and leaving sturgeon vulnerable to perturbations of natural river conditions at different life stages (Cooke and Leach 2004; Kynard 1997). Sturgeon spawning sites remain unknown for the majority of rivers in their range. Observations of sturgeon spawning immediately below dams, further suggests that they are unable to reach their preferred spawning habitat upriver. Overall, 91 percent of historic Atlantic sturgeon habitat seems to be accessible, but the quality of the remaining portions of habitat as spawning and nursery grounds is unknown, therefore estimates of percentages of availability do not necessarily equate to functionality (ASSRT 2007b). Thus, dams may one of the primary causes of the extirpation of sturgeon subpopulations on the east coast.

The suitability of riverine habitat for sturgeon spawning and rearing depends on annual fluctuations in water flow, which can be greatly altered or reduced by the presence and operation of dams (Cooke and Leach 2004; Jager et al. 2001). Effects on spawning and rearing may be most dramatic in hydropower facilities that operate in peaking mode (Auer 1996; Secor and Niklitschek 2002). Daily peaking operations store water above the dam when demand is low and release water for electricity generation when demand is high, creating substantial daily fluctuations in flow and temperature regimes. Kieffer and Kynard (2012) reported extreme flow fluctuations for hydroelectric power generation on the Connecticut River affected access to shortnose sturgeon spawning habitat, possibly deterred spawning, and left rearing shoals either completely scoured during high flows or dry and exposed during low flows.

Table 14. First upstream dam locations and year built for major rivers within the action area. Source: adapted from NMFS (2017).

River	First Dam (Year Built)	River Kilometer
Penobscot	Veazie (1834)	56
Kennebec Complex: Androscoggin	Brunswick (1948)	44
Kennebec Complex: Kennebec	Lockwood Dam[1] (1919)	98
Piscataqua	None	
Merrimack	Essex Dam (1848)	46
Connecticut	Holyoke Dam[2] (1849)	140
Housatonic	Derby Dam (1870)	23
Hudson	Troy Dam (1825)	245
Delaware	None	
Susquehanna	Conowingo Dam (1928)	16
Potomac	Little Falls Dam (1959)	189
Roanoke	Roanoke Rapids Dam (1955)	221
Chowan River Basin	Emporia Dam, Meherrin (1918)	203
Tar-Pamlico (Tar River)	Rocky Mount Mills Dam (1971)	199
Neuse	Milburnie Dam[3] (1903)	341
New	None	
Cape Fear	Lock and Dam #1 (1915)	97
Winyah Bay/Pee Dee	Blewett Falls Dam (1912)	330
Santee	Santee (1940s) and St Stephens Dam[4] (1985)	143 and 92
Cooper	Pinopolis Dam (1942)	77
ACE Basin	None	
Savannah	New Savannah Bluff Lock & Dam (1937)	317
Ogeechee	Jordan Mill Pond Dam	375
Altamaha	None[5]	
Satilla	None	
St. Mary's	None	
St. Johns, Ocklawaha River	Rodman Dam[6] (1968)	13

[1]Edwards Dam (1837; rkm 59), formerly the first dam on Kennebec River, was removed in 1999.
[2]Enfield Dam (1880; rkm 109), formerly the first obstruction on CT River, was breached in the 1970s.
[3]The Quaker Neck Dam, built in 1952 at rkm 225 was removed in 1998.
[4]The Santee (or Wilson) Dam is on the Santee River; the St Stephens Dam is on the rediversion canal.

[5]There are no dams on the main stem of the Altamaha River; however, there are dams on both the Oconee (Sinclair Dam at rkm 444) and Ocmulgee (Juliet Dam at rkm 573)
[6]The first dam (Rodman) is on Ocklawaha River 12.9 km upstream of its confluence with St John River.

Several dams within the Atlantic sturgeon historic range have been removed or naturally breached. Sturgeon appear unable to use some fishways (e.g., ladders) but have been transported in fish lifts (Kynard 1998). Data on the effects of the fish lift at the Holyoke Hydroelectric Project on the Connecticut River suggest that fish lifts that successfully attract other anadromous species (i.e., shad, salmon etc.) do a poor job of attracting sturgeon: attraction and lifting efficiencies for shortnose sturgeon at the Holyoke Project are estimated around 11 percent (ASSRT 2007a). Despite decades of effort, fish passage infrastructure retrofitted at hydroelectric dams has largely failed to restore diadromous fish to historical spawning habitat (Brown et al. 2013). While improvements to fish passage are often required when hydroelectric dams go through Federal Energy Regulatory Commission relicensing, the relicensing process occurs infrequently, with some licenses lasting up to 50 years. Over 95 percent of dams on the eastern seaboard are not hydroelectric facilities, and are thus not subject to continual relicensing or fish passage improvement measures (ASMFC 2008).

5.1.3 Dredging

Riverine, nearshore, and offshore coastal areas are often dredged to support commercial shipping, recreational boating, construction of infrastructure, and marine mining. Dredging in spawning and nursery grounds modifies habitat quality, and limits the extent of available habitat in some rivers where anadromous fish habitat has already been impacted by the presence of dams. Negative indirect effects of dredging include changes in DO and salinity gradients in and around dredged channels (Campbell and Goodman 2004; Jenkins et al. 1993; Secor and Niklitschek 2001). Adult shortnose sturgeon can tolerate at least short periods of low DO and high salinities, but juveniles are less tolerant of these conditions in laboratory studies. Collins et al. (2000) concluded harbor modifications in the lower Savannah River have altered hydrographic conditions for juvenile sturgeon by extending high salinities and low DO upriver.

Dredging and filling operations impact important habitat features of Atlantic sturgeon as they disturb benthic fauna, eliminate deep holes, and alter rock substrates (Smith and Clugston 1997b). Dredging operations may also pose risks to anadromous fish species by destroying or adversely modifying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. As benthic omnivores, sturgeon are particularly sensitive to modifications of the benthos that affect the quality, quantity and availability of prey species. Nellis et al. (2007) documented that dredge spoil drifted 12 km downstream over a ten-year period in the Saint Lawrence River, and that those spoils have significantly less macrobenthic biomass compared to control sites. Hatin et al. (2007) reported avoidance behavior by Atlantic sturgeon during dredging operations and McQuinn and Nellis (2007) found that Atlantic sturgeon were substrate dependent and avoided dredge spoil dumping grounds.

In addition to indirect impacts, hydraulic dredging can directly harm sturgeon and sea turtles by lethally entraining fish up through the dredge drag-arms and impeller pumps. Between 1990 and 2005, 10 Atlantic sturgeon were reported captured by hopper dredges (ASSRT 2007b). Atlantic sturgeon have been taken in both hydraulic pipeline and bucket-and-barge operations in the Cape Fear River, North Carolina (Moser and Ross 1995). Mechanical dredges (i.e., clamshell) have also been documented to kill Atlantic sturgeon (Hastings 1983). Dickerson (2006) reported 15 Atlantic sturgeon taken in dredging activities conducted by the U.S. Army Corps of Engineers from 1990-2010, most captured by hopper dredge. Notably, these reports include only those trips when an observer was on board to document capture.

5.1.4 Liquefied Natural Gas Facilities

Natural gas is chilled to approximately -260 °F (-162.2 ºC) into liquid form for transportation overseas. The liquefied natural gas (LNG) is loaded onto tankers and upon arrival in the United States is converted back into a gas for distribution via pipeline. LNG is re-gasified by circulating water (or some other fluid) through a radiator-like system that warms LNG to vaporization temperatures. LNG facilities use either a closed-loop or open-loop system to convert the liquid into gas. Open-loop systems require a continuous stream of water in order to warm LNG (100-200 million gallons per day), usually withdrawn directly from the river system or ocean in which the terminal is sited. Eggs, larvae, and other organisms in the water column can be impinged or entrained as water is withdrawn from the source to the terminal. Once the LNG is vaporized, the seawater used in cooling is either discharged back into the environment or utilized again through the cooling loop. The discharge can be at temperatures significantly different from ambient. Potential threats/impacts to sturgeon associated with the construction and operation of LNG facilities include increased dredging activities to allow for the passage and berthing of LNG vessels, pile driving for pier and berth construction, increased risk of ship strikes due to vessel traffic, potential early life stage losses from ballast water and facility intakes, loss of habitat due to water withdrawal, and increased ambient water temperature from discharged water. Demand for liquefied natural gas (LNG) is predicted to increase, and there are several proposals to build new or expand existing LNG facilities in or near river systems with populations of shortnose sturgeon (FERC website accessed January 26, 2017: https://www.ferc.gov/industries/gas/indus-act/lng.asp).

Existing LNG import terminals within the action area are located in Saint John (New Brunswick), Everett (Massachusetts), Cove Point (Maryland), Elba Island/Savannah (Georgia), and two offshore of Gloucester (Massachusetts). Two LNG export terminals are currently under construction (Cove Point, Maryland and Elbas Island, Georgia) and LNG terminals have been proposed for offshore from Long Island, New York and Jacksonville, Florida (FERC website accessed January 26, 2017: https://www.ferc.gov/industries/gas/indus-act/lng.asp).

5.1.5 Industrial and Power Generating Plants

Industrial and power generating plants (e.g., hydro, steam, coal, nuclear) located within the action area can adversely affect ESA-listed species including sturgeon, salmon and sea turtles. Stressors to Atlantic and shortnose sturgeon caused by these operations include impingement and entrainment, thermal discharges, chemical discharges, and the indirect effect of prey reduction. Impingement occurs when organisms are trapped against cooling water intake screens, racks, or removal equipment by the force of moving water. Adult, juvenile, and larval sturgeon are known to be killed or injured due to impingement on cooling water intake screens (Dadswell et al. 1984; Hoff and Klauda 1979). Entrainment occurs when marine organisms enter the intake water flow and pass through the cooling water intake structure and into a cooling water system. Adult sturgeon and salmon are too large to be entrained, but sturgeon eggs and larvae are potentially susceptible to entrainment. Sea turtles entering coastal or inshore areas can also be affected by impingement in cooling-water intake systems

Power plants withdraw water from rivers, pumping the water through the plants to cool the reactors, and then discharging the heated water back to rivers. Some discharges have been measured as high as 46°C (Hester and Doyle 2011). Thermal plumes resulting from cooling water intake structure represent one of multiple factors that can interact with one another to affect the fitness of sturgeon. Sturgeon experience lower survival when water temperatures exceed 28°C (Niklitschek and Secor 2005). Increases in water temperature have been shown to increase the susceptibility of sturgeon to hypoxia (Secor and Niklitschek 2001). Sturgeon are more sensitive to low level DO conditions than other fishes, possessing limited behavioral and physiological capacity to respond to hypoxia. In experiments on Atlantic sturgeon, the effect of oxygen level on routine metabolism, consumption, feeding metabolism, growth, and survival has been shown to be conditional on temperature (Secor and Niklitschek 2001). To avoid lethal and sublethal effects, sturgeon must avoid temperatures above 33.7°C with complete oxygen saturation (Ziegeweid et al. 2008) or hypoxic conditions, particularly as water exceeds about 15°C (Secor and Gunderson 1998).

Chemical discharges from cooling water intake structure may include radionuclides, including tritium, strontium, nickel, and cesium. Chlorine, lithium hydroxide, boron, and total suspended solids may also be discharged from cooling water intake structure. Total residual chlorine at cooling water intake structure is often limited to a maximum daily average of 0.2mg/L, as measured at the point of discharge, prior to dilution in the water body. Campbell and Davidson (2007) describe a 50 percent mortality rate (i.e., 96 hour LC50) of young and juvenile white sturgeon when kept for 4 hours at chlorine concentrations of 0.034 – 0.042 mg/L.

Recent regulations have been implemented by the U.S. Environmental Protection Agency (USEPA) to reduce the risk of jeopardizing the continued existence of federally-listed species due to the impact of impingement and entrainment of cool water intakes at industrial facilities.

Specifically, the USEPA promulgated a Clean Water Act (CWA) section 316(b) regulation on August 15, 2014, establishing standards for cooling water intake structures (79 FR 48300-439 2015) and mandating the best technology available to reduce impingement and entrainment of aquatic organisms. As the rule is implemented, through individual ESA section 10(a)(1)(B) plant consultations with the USFWS and NMFS, it will include a number of provisions designed to reduce and monitor such takes at the cool water intakes. The risks to ESA-listed species being entrained or impinged at these industrial sites will be monitored into the future and should be lessened.

In an effort to reduce carbon emissions worldwide, marine renewable energy projects (i.e., marine wind, wave, tidal, ocean current, and thermal gradient) are gaining in popularity as an alternative source of energy. Marine renewable energy projects within the action area that have been developed include commercial wind leasing offshore from Block Island, Rhode Island (and proposed off of several states) and the Maine Tidal Energy Project in the Bay of Fundy (https://www.boem.gov/Renewable-Energy-State-Activities/; http://www.orpc.co/projects_maine.aspx). Several other renewable energy projects along the Atlantic coast have been proposed or are currently under review. As with any large-scale development in the marine environment, however, these projects come with uncertainty about potential environmental impacts (Boehlert and Gill 2010b). Some of the anticipated projected effects are common with other types of development in the marine environment; for example, additional structures lead to concerns for entanglement, habitat change, and community change (Boehlert and Gill 2010b). However, the specific impacts of marine renewable energy projects on the ESA-listed species considered in this opinion have not been adequately evaluated.

5.1.6 Water Quality and Contaminants

Water quality in riverine and estuarine systems is affected by human activities conducted in the riparian zone, as well as 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 DO, 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 stormwater discharges, non-point source pollution, and erosion. The CWA regulates pollution discharges into waters of the United States from point sources; however, it does not regulate non-point source pollution.

Chemicals such as chlordane, dichlorodiphenyl dichloroethylene (DDE), dichloro-diphenyl-trichloroethane (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 have recently been documented to affect physiological processes and development of larval life stages, 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 (Chambers et al. 2012).

Water quality over the range of ESA-listed species considered in this Opinion varies by region and watershed. USEPA recently published its fifth edition of the National Coastal Condition Report, a "report card" summarizing the status of coastal environments as of 2010 (EPA 2015). The report analyzes water quality, sediment, coastal habitat, benthos, and fish contaminant indices to determine status on a range from good to fair to poor. A summary of the results for the Northeast (Virginia to Maine) and Southeast (North Carolina to Florida) regions is shown below in Figure 13 and Figure 14, respectively. More than one-half of the coastal areas in both regions along the Atlantic coast were rated as either poor or fair for phosphorous, chlorophyll, and overall water quality index. Ecological fish tissue quality also received low ratings, particularly in the Southeast region where over one-half of the coastal area was rated as "poor" for this criterion.

Life histories of sturgeon species (i.e., long lifespan, extended residence in estuarine habitats, benthic foraging) predispose them to long-term, repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979). However, there has been little work on the effects of contaminants on sturgeon to date. Shortnose sturgeon collected from the Delaware and Kennebec Rivers had total toxicity equivalent concentrations of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), PCBs, DDE, aluminum, cadmium, and copper all above adverse effect concentration levels reported in the literature (Brundage III 2008). Dioxin and furans were detected in ovarian tissue from shortnose sturgeon caught in the Sampit River/Winyah Bay system (South Carolina). Early life stage Atlantic and shortnose sturgeon are vulnerable to PCB and Tetrachlorodibenzo-p-dioxin (TCDD) toxicities of less than 0.1 parts per billion (Chambers et al. 2012).

Heavy metals and organochlorine compounds accumulate in sturgeon tissue, but their long-term effects are not known (Ruelle and Keenlyne 1993). High levels of contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Billsson 1998; Cameron et al. 1992; Giesy et al. 1986; Hammerschmidt et al. 2002), reduced survival of larval fish (McCauley et al. 2015; Willford et al. 1981), delayed maturity and posterior malformations (Billsson 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; Waring and Moore 2004a; Waring and Moore 2004b).

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

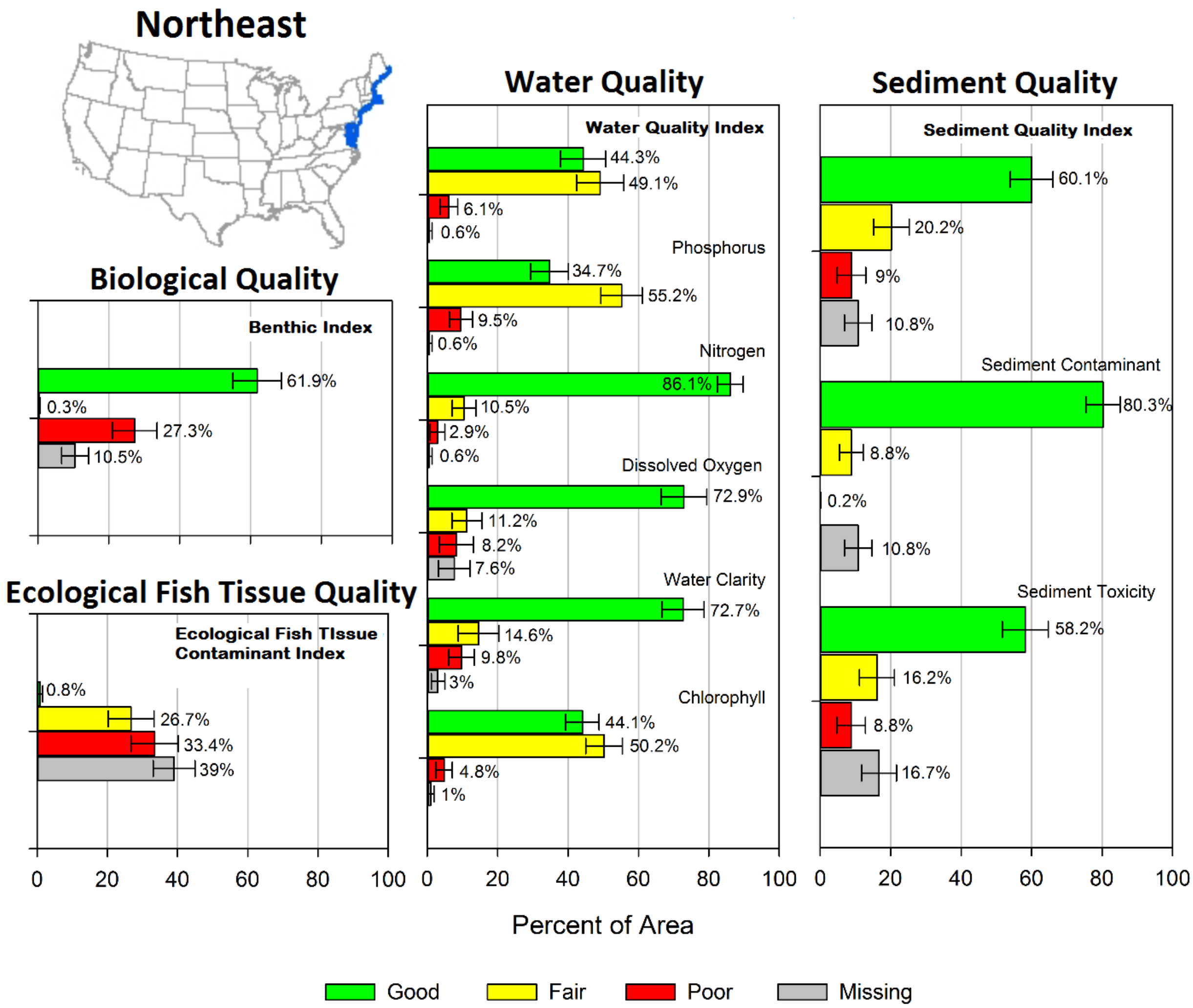

Figure 13. National Coastal Condition Assessment 2010 Report findings for the Northeast Region. Bars show the percentage of coastal area within a condition class for a given indicator. Error bars represent 95 percent confidence levels (EPA 2015).

(Rosenthal and Alderdice 1976). Increased doses of PCBs and TCDD have been correlated with reduced physical development of Atlantic sturgeon larvae, including reductions in head size, body size, eye development and the quantity of yolk reserves (Chambers et al. 2012). Juvenile shortnose sturgeon raised for 28 days in North Carolina's Roanoke River had a 9 percent survival rate compared to a 64 percent survival rate at non-riverine control sites (Cope et al. 2011). The reduced survival rate could not be correlated with contaminants, but significant quantities of retene, a paper mill by-product with dioxin-like effects on early life stage fish, were detected in the river (Cope et al. 2011). Dwyer et al. (2005) compared the relative sensitivities of common surrogate species used in contaminant studies to 17 ESA-listed species including 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 and permethrin. Of the ESA-listed species, Atlantic sturgeon were ranked the

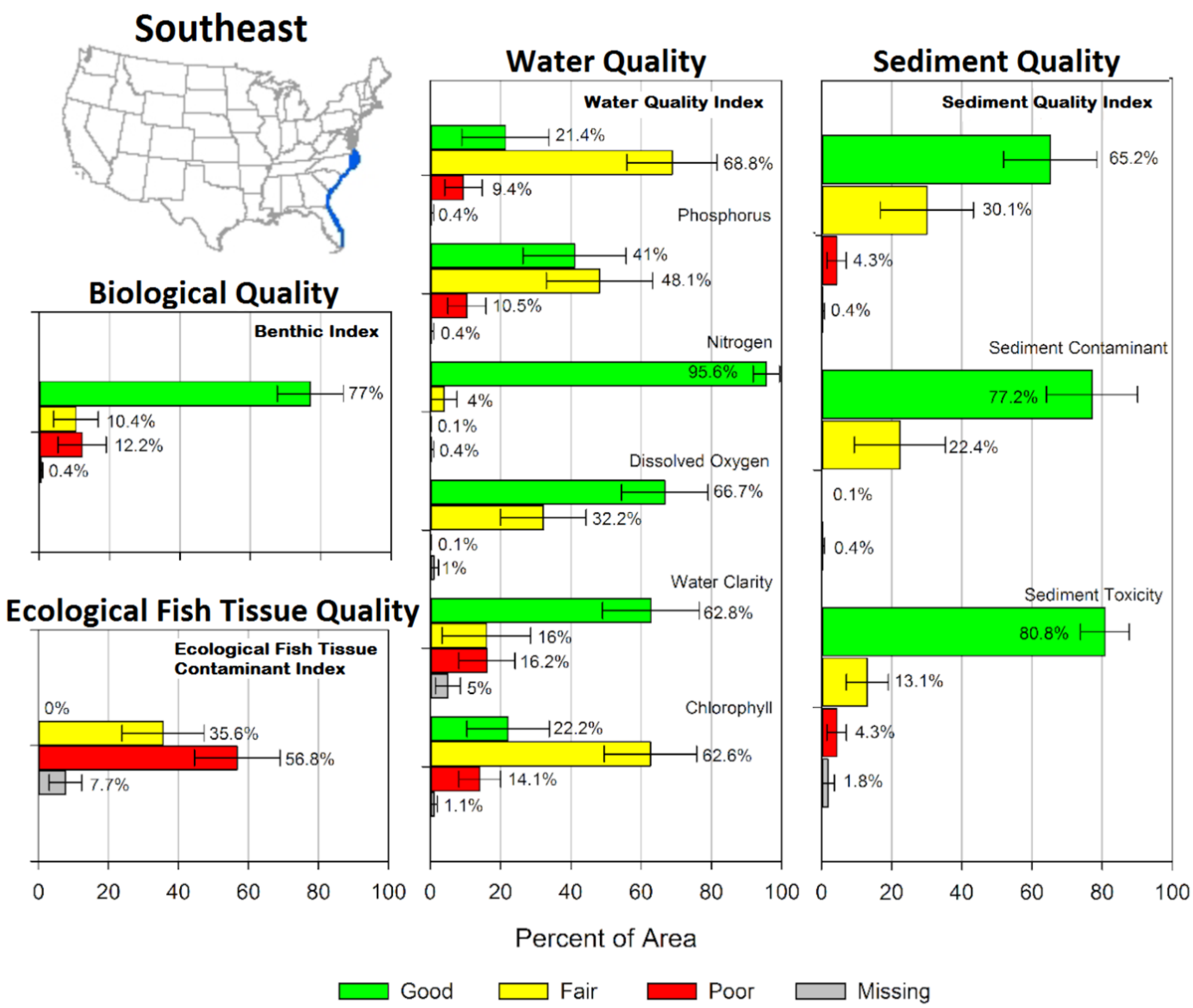

Figure 14. National Coastal Condition Assessment 2010 Report findings for the Southeast Region. Bars show the percentage of coastal area within a condition class for a given indicator. Error bars represent 95 percent confidence levels (EPA 2015).

most sensitive species tested for four of the five chemicals (Atlantic and shortnose sturgeon were found to be equally sensitive to permethrin). 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).

Increases in fecal coliform and estradiol concentrations may also affect ESA-listed fish species. These compounds can enter the aquatic environment via wastewater treatment plants, agricultural facilities, and runoff from farms. The impact of many of these waterborne contaminants on Atlantic sturgeon is unknown, but they are known to affect other species of fish in rivers and streams. For instance estrogenic compounds are known to affect the male to female sex ratio of carp via decreased gonadal development, physical feminization and sex reversal (Folmar et al. 1996). Although the effects of these contaminants are unknown in Atlantic sturgeon, Omoto et al. (2002) found that by varying the oral doses of estradiol-17β or 17α-methyltestosterone given to captive hybrid (*Huso huso* female × *Acipenser ruthenus* male) “bester” sturgeon they could induce abnormal ovarian development or a lack of masculinization. These compounds, along with high or low DO concentrations, can result in sub-lethal effects that may have negative consequences for at risk fish populations.

A variety of heavy metals, including arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc, have been found in sea turtles tissues in levels that increase with turtle size (Barbieri 2009; Fujihara et al. 2003; García-Fernández et al. 2009; Godley et al. 1999; Storelli et al. 2008). Cadmium has been found in leatherbacks at the highest concentration compared to any other marine vertebrate (Gordon et al. 1998). Newly emerged hatchlings have higher concentrations than are present when laid, suggesting that metals may be accumulated during incubation from surrounding sands (Sahoo et al. 1996). Arsenic has been found to be very high in green sea turtle eggs (Van de Merwe et al. 2009). Sea turtle tissues have been found to contain organochlorines, including chlorobiphenyl, chlordane, lindane, endrin, endosulfan, dieldrin, perfluorooctane sulfonate, perfluorooctanoic acid, DDT, and PCB (Alava et al. 2006; Gardner et al. 2003; Keller et al. 2005; Oros et al. 2009; Storelli et al. 2007). PCB concentrations are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (Davenport et al. 1990; Oros et al. 2009). Levels of PCBs found in green sea turtle eggs are considered far higher than what is fit for human consumption (Van de Merwe et al. 2009). It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller et al. 2006; Oros et al. 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007), and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

5.1.7 Fisheries

Commercial, recreational, and subsistence fisheries can result in substantial detrimental impacts on populations of ESA-listed species. Past fisheries contributed to the steady decline in the population abundance of many ESA-listed anadromous fish species. Although directed fishing for the species covered in this opinion is prohibited under the ESA, many are still captured as "bycatch" in fishing operations targeting other species. Bycatch occurs when fishing operations interact with marine mammals, sea turtles, fish species, corals, sponges, or seabirds that are not the target species for commercial sale.

5.1.7.1 Directed Harvest

Atlantic sturgeon exhibit an unusual combination of morphology, habits, and life history characteristics, which make them highly vulnerable to impacts from commercial fisheries. Prior to 1890, Atlantic sturgeon populations were at or near carrying capacity. Between 1890 and 1905, Atlantic sturgeon populations were drastically reduced due to overfishing for sale of meat and caviar. Harvest records indicate that fisheries for sturgeon were conducted in every major coastal river along the Atlantic coast at one time, with fishing effort concentrated during spawning migrations (Smith 1985). Approximately 3,350 metric tons (7.4 million pounds) of sturgeon (Atlantic and shortnose combined) were landed in 1890 (Smith and Clugston 1997b). The sturgeon fishery during the early years (1870 to 1920) was concentrated in the Delaware River and Chesapeake Bay systems. Between 1920 and 1998, harvest levels remained low due to small remnant populations. During the 1970s and 1980s sturgeon fishing effort shifted to the South Atlantic, which accounted for nearly 80 percent of total U.S. landings (64 metric tons). By 1990 sturgeon landings were prohibited in Pennsylvania, District of Columbia, Virginia, South Carolina, Florida, and waters managed by the Potomac River Fisheries Commission. From 1990 through 1996 sturgeon fishing effort shifted to the Hudson River (annual average 49 metric tons) and coastal areas off New York and New Jersey (Smith and Clugston 1997b). By 1996, closures of the Atlantic sturgeon fishery had been instituted in all Atlantic Coast states except for Rhode Island, Connecticut, Delaware, Maryland, and Georgia, all of which adopted a seven-foot minimum size limit. Prompted by research on juvenile production between 1985 and 1995 (Peterson et al. 2000), the Atlantic sturgeon fishery was closed by the ASMFC in 1998 when a coast-wide fishing moratorium was imposed for 20-40 years, or at least until 20 year classes of mature female Atlantic sturgeon were present (ASMFC 2008). NMFS followed this action by closing the Exclusive Economic Zone to Atlantic sturgeon take in 1999. Poaching of Atlantic sturgeon continues and is a potentially significant threat to the species, but the present extent and magnitude of such activity is largely unknown.

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters. Sturgeon belonging to one or more of the ESA-listed DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy sturgeon fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the GOM and New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (Wirgin et al. 2015). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species , the U.S. and Canada are currently working on a conservation strategy to address the potential for captures of U.S. fish in Canadian-directed Atlantic sturgeon fisheries and of Canadian fish incidentally captured in U.S. commercial fisheries. There are no current estimates of the number of Atlantic sturgeon captured or killed in Canadian fisheries each year. Based on geographic distribution, most U.S. Atlantic sturgeon intercepted in Canadian fisheries have originated from the GOM DPS, with a smaller percentage from the New York Bight DPS.

5.1.7.2 Bycatch

Directed harvest of Atlantic and shortnose sturgeon is prohibited in U.S. waters. However, sturgeon are taken incidentally in fisheries targeting other species in rivers, estuaries, and marine waters throughout their range (ASSRT 2007a; Collins et al. 1996). Atlantic sturgeon (from all five DPSs) and shortnose sturgeon are at risk of bycatch-related mortality in fisheries operating within and beyond the action area. Because sturgeon mix extensively in marine waters and may access several river systems, they are subject to being caught in multiple fisheries throughout their range. Commercial fishery bycatch represents a significant threat to the viability of listed sturgeon species and populations. Bycatch could have a substantial impact on the status of Atlantic sturgeon, especially in rivers or estuaries that do not currently support a large subpopulation (< 300 spawning adults per year). Reported mortality rates of sturgeon (Atlantic and shortnose) captured in inshore and riverine fisheries range from 8 percent to 20 percent (Bahn et al. 2012; Collins et al. 1996).

Sturgeon are benthic feeders and as a result they are generally captured near the seabed unless they are actively migrating (Moser and Ross 1995). Sturgeon are particularly vulnerable to being caught in commercial gill nets; therefore, fisheries using this type of gear account for a high percentage of sturgeon bycatch and bycatch mortality. Sturgeon have also been documented in the following gears: otter trawls, pound nets, fyke/hoop nets, catfish traps, shrimp trawls, and recreational hook and line fisheries.

Several federally regulated fisheries that may encounter Atlantic sturgeon have fishery management plans (FMPs) that have undergone section 7 consultation with NMFS. On December 16, 2013, NMFS issued a “batched” section 7 biological opinion on the following fisheries: Northeast multispecies; monkfish; spiny dogfish; Atlantic bluefish; Northeast skate complex; mackerel/squid/butterfish; and summer flounder /scup/black sea bass. The Northeast multispecies fishery includes American plaice, Atlantic cod, Atlantic halibut, Atlantic wolfish, haddock, ocean pout, offshore hake, pollock, redfish, red hake, silver hake, white hake, windowpane flounder, winter flounder, witch flounder, and yellowtail flounder. Gill net gear is used by five of the seven fisheries, and bottom trawl gear is used by six of the seven fisheries. It is also possible that bottom longline gear, which is used in the Northeast multispecies, monkfish, and spiny dogfish fisheries, could hook Atlantic sturgeon while foraging, but there have been no reported interactions. The majority (73%) of all Atlantic sturgeon bycatch mortality in New England and Mid-Atlantic waters is attributed to the monkfish sink gill net fishery (ASMFC 2007). Observer data from 2001 to 2006 shows 224 recorded interactions between the monkfish fishery and Atlantic sturgeon, with 99 interactions resulting in death, a 44 percent mortality rate.

Fishing activity under the authority of many of the FMPs considered in the batched biological opinion often occurs simultaneously and on the same vessel, making the link between FMPs and sturgeon interactions difficult to quantify. Therefore, interactions with Atlantic sturgeon were analyzed based on gear type. For all seven fisheries, the following take of Atlantic sturgeon was authorized annually: 1,331 trawl interactions of which 42 may be lethal and 1,229 gill net interactions of which 155 may be lethal (Table 15). These estimates do not account for all actual Atlantic sturgeon bycatch in federal fisheries, but if these take levels are exceeded, consultation must be reinitiated. The 2012 NMFS biological opinion on the Southeast shrimp trawl fishery concluded the fishery is unlikely to jeopardize Atlantic sturgeon. This biological opinion exempted the take of Atlantic sturgeon as follows: 1,731 total interactions, including 243 captures of which 27 are expected to be lethal every three years. In 2012, NMFS provided an updated biological opinion on the Federal shark fisheries, including the smoothhound fishery on ESA-listed species. Observer reports through 2011 indicated that Atlantic sturgeon captures in shark directed gill net sets are uncommon but they do occur and have occurred in similar gears. Atlantic sturgeon bycatch in the smoothhound fishery are known to be significantly higher than in the shark fisheries. For the federal smoothhound fishery and shark fisheries combined, NMFS exempted the take of 321 Atlantic sturgeon over a three-year span, with 66 of those takes expected to be lethal (Table 15).

Estimated rates of Atlantic sturgeon caught as bycatch in federal fisheries are highly variable and somewhat imprecise due to small sample sizes of observed trips. An estimated 1,385 individual Atlantic sturgeon were killed annually from 1989-2000 as a result of bycatch in offshore gill net fisheries operating from Maine through North Carolina (Stein et al. 2004b). From 2001-2006 an estimated 649 Atlantic sturgeon were killed annually in offshore gill net and otter trawl fisheries. From 2006-2010 an estimated 391 Atlantic sturgeon were killed (out of 3,118 captured) annually in Northeast federal fisheries (Miller and Shepherd 2011).

Given the high prevalence of gill net and otter trawl use in nearshore coastal and inland fisheries, state managed fisheries may have a greater impact on sturgeon than federal fisheries using these same gear types. Commercially important state fisheries that interact with sturgeon include those targeting shrimp, Atlantic croaker, weakfish, striped bass, black drum, spot, shad, and spiny dogfish. The Recovery Plan for shortnose sturgeon (NMFS 1998) lists commercial and recreational shad fisheries as a source of bycatch. Adult shortnose sturgeon are believed to be especially vulnerable to fishing gears for anadromous species (such as shad, striped bass, alewives and herring) during times of extensive migration – particularly their spawning migration (Litwiler 2001). Shortnose sturgeon bycatch in the southern trawl fishery for shrimp (*Penaerrs spp.*) was estimated at 8 percent (Collins et al. 1996). Bycatch of shortnose sturgeon from the shad gillnet fisheries can be quite substantial. Catch rates in drift gillnets are believed to be lower than for fixed nets, longer soak times appear to be correlated with higher rates of mortalities, and the cooler water temperatures likely increase release survivability of shortnose sturgeon. Of the 51 shortnose sturgeon captured in the South Carolina American shad gillnet fishery, 16 percent resulted in bycatch mortality and another 20 percent were visibly injured (Collins et al. 1996).

Table 15. Anticipated annual incidental take (captures and mortalities) of Atlantic sturgeon as outlined in the opinions on NMFS-authorized federal fisheries (shown by fishery and by Distinct Population Segment).

Take by Federal Fishery	Exempted average annual **total captures** (lethal and nonlethal)	Exempted average annual **mortalities**
Seven batched federal fisheries (Dec.16, 2013)	2,560	197
Southeast shrimp trawl (May 8, 2012)	274	34
Shark and smoothhound under consolidated Highly Migratory Species FMP	107	22
Atlantic sea scallop (July 12, 2012)	1	.05 (1 every 20 years)
Total		253.05
Take by DPS	Exempted average annual **total captures** (lethal and nonlethal)	Exempted average annual **mortalities**
GOM	313	27
New York Bight	1414	116
Chesapeake Bay	384	34
Carolina	108	13
South Atlantic	722	63
Total	2942	253.05

In 2013, after amending their commercial fishing regulations to minimize incidental capture, the Georgia Department of Natural Resources received an ESA section 10 permit for incidental take of Atlantic sturgeon in the commercial shad fishery in state waters. The incidental take permit (ITP) allows the capture and live release of up to 180 Atlantic sturgeon annually, with a maximum of five incidental mortalities per year. A mortality rate of approximately 2.3 percent is anticipated based on recent research. The North Carolina Division of Marine Fisheries (NCDMF) developed a Conservation Plan to address Atlantic sturgeon take in the state’s inshore gill net fishery, and submitted an application for an ESA ITP to NMFS in April of 2012. In July 2014, NCDMF received an ESA section 10 permit for incidental take of Atlantic sturgeon that allows for take of up to 2,927 juvenile and small subadult Atlantic sturgeon annually, primarily in the form of capture and harassment, but in some cases lethal take.

NCDMF reported that no Atlantic sturgeon were observed in 958 observed tows conducted from 2001 to 2008 by commercial shrimp trawlers working in North Carolina waters (NCDMF 2014). Yet Collins et al. (1996) reported that of 1,534 juvenile Atlantic sturgeon tagged in the Altamaha River, Georgia, 38 out of 97 (39 percent) were recaptured in shrimp trawls with the remainder captured in gill net fisheries. Seven adult Atlantic sturgeon were captured (one killed) by a single shrimp trawler off Winyah Bay, South Carolina in October 2008 (Damon-Randall et al. 2010).

Commercial fisheries bycatch also represents a significant threat to sea turtles throughout the action area. Finkbeiner et al. (2011) compiled cumulative estimates of sea turtle bycatch across fisheries of the United States between 1990 and 2007, before and after implementation of fisheries-specific bycatch mitigation measures. Pre- and post-regulatory strata were identified for each fishery based on the first year a sea turtle bycatch mitigation strategy was mandated. For the Atlantic region, an annual mean of 345,800 turtle interactions and 70,700 deaths was estimated for the pre-regulatory strata across all fisheries included in this study. By comparison, an annual mean of 137,700 turtle interactions and 4,500 deaths was estimated for the post-regulatory strata.

By species, Kemp’s ridley turtles suffer the highest absolute estimated mortality from fisheries bycatch in the post-regulatory period. Approximately 2,700 Kemp’s ridleys are killed annually as a result of 98,300 interactions, primarily from shrimp trawl fisheries (Finkbeiner et al. 2011). While this comprises a substantial fraction of the number of annual nesting females from the Northwest Atlantic and Gulf of Mexico rookeries combined, the current mortality estimate represents a substantial reduction in Kemp’s ridley annual mortality from the period prior to Turtle Exclusion Device regulations. Loggerheads interact with more different types of fisheries than any other sea turtle species in the U.S. Atlantic (26,500 annual interactions), resulting in an estimated 1,400 annual deaths in the post-regulatory period (Finkbeiner et al. 2011). Even with Turtle Exclusion Device regulations in place, the shrimp trawl fishery remains a threat to the Florida nesting population which constitutes 90 percent of total U.S. loggerhead nesting in the Atlantic Ocean and exhibited a 43 percent decline from 1998 to 2006 (Witherington et al. 2009). Estimated mean annual bycatch interactions and mortalities in Atlantic fisheries in the post-regulatory periods for other sea turtles are as follows: green turtle 11,400 interactions, 300 mortalities; leatherback 1,400 interactions, 40 mortalities; and hawksbill < 10 interactions and mortalities.

5.1.8 Ship Strikes

Large sturgeon are susceptible to vessel collisions. The factors relevant to determining the risk to sturgeon from vessel strikes are currently unknown, but are likely related to size and speed of the vessels, navigational clearance (i.e., depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of sturgeon in the area (e.g., foraging, migrating, etc.). The

ASSRT determined Atlantic sturgeon in the Delaware River are at a moderately high risk of extinction because of ship strikes, and sturgeon in the James River are at a moderate risk from ship strikes (ASSRT 2007a). Balazik et al. (2012) estimated up to 80 sturgeon were killed between 2007 and 2010 in these two river systems. Brown and Murphy (2010) examined 28 dead Atlantic sturgeon from the Delaware River from 2005 through 2008 and found that fifty percent of the mortalities resulted from apparent vessel strikes, and 71 percent of these (10 out of 14) had injuries consistent with being struck by a large vessel. Eight of the fourteen vessel-struck sturgeon were adult-sized fish which, given the time of year the fish were observed, were likely migrating through the river to or from the spawning grounds. Ship strikes may also be threatening Atlantic sturgeon populations in the Hudson River where large ships move from the river mouth to ports upstream through narrow shipping channels. The channels are dredged to the approximate depth of the ships, usually leaving less than 6 feet of clearance between the bottom of ships and the river bottom. Any aquatic life along the bottom is at risk of being sucked up through the large propellers of these ships.

Large sturgeon are most often killed by ship strikes because their size means they are unable to pass through the ship's propellers without making contact. Shortnose sturgeon may not be as susceptible due to their smaller size in comparison to the larger Atlantic sturgeon, for which ship strikes have been documented more frequently. There has been only one confirmed incidence of a ship strike on a shortnose sturgeon in the Kennebec River, and two suspected ship strike mortalities in the Delaware River (SSSRT 2010).

Propeller and collision injuries from private and commercial vessels are also a significant threat to ESA-listed sea turtles. Turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to vessel strikes, which can result in serious injury and death (Hazel et al. 2007). From 1997 to 2005, nearly 15 percent of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having sustained some type of propeller or collision injury; although it is not known what proportion of these injuries were post or ante-mortem. The incidence of propeller wounds has risen from approximately 10 percent in the late 1980s to 20.5 percent in 2004. The Sea Turtle Stranding and Salvage Network reports a large number of vessel interactions (propeller injury) with sea turtles off coastal states such as New Jersey and Florida, where there are high levels of vessel traffic. The Virginia Aquarium & Marine Science Center Strandings Program reported an average of 62.3 sea turtle strandings per year in Virginia waters due to boat strikes from 2009-2014 (Barco 2015). The large majority of these (~ 87 percent) are dead strandings. By sea turtle species, 73.3 percent of Virginia vessel strike strandings from 2009-2014 were loggerhead, 20.3 percent Kemp's ridley, 3.5 percent green, and 2.9 percent leatherback (Barco 2015).

5.1.9 Scientific Research

Information obtained from scientific research is essential for understanding the status of ESA-listed species, obtaining specified critical biological information, and achieving species recovery goals. Research on ESA-listed species is granted an exemption to the ESA take prohibitions of section 9 through the issuance of section 10(a)(1)(A) permits. Research activities authorized on wild and captive sturgeon through scientific research permits can produce various stressors on individual shortnose and Atlantic sturgeon resulting from capture, handling, and research procedures. As required by regulation, research conducted under a section 10(a)(1)(A) research permit cannot operate to the disadvantage of the species. Scientific research permits issued by NMFS are conditioned with mitigation measures to ensure that the impacts of research activities on target and non-target ESA-listed species are as minimal as possible. See Section 6 “Effects of the Action” for a full discussion of the stressors on wild sturgeon populations resulting from research activities, as well as the measures in place to avoid and minimize their effects.

There are currently 17 active section 10(a)(1)(A) shortnose and Atlantic sturgeon scientific research permits (Appendix E). Thirteen of these permits will expire in early 2017; three permits expire in 2018. Most of the current permit holders have submitted their new permit applications to continue sturgeon research in 2017 and beyond. Each permit authorizes sampling of adult through juvenile life stages, and some permits have authorization to collect early life stages (early life stages). A biological opinion was issued for each of the five-year permits authorized for Atlantic and shortnose sturgeon, including the requirement for consideration of cumulative effects to the species (as defined for the ESA). For each permit, the biological opinion concluded that permit issuance was not likely to jeopardize the continued existence of the species or DPS.

Since 2006, conservative mitigation measures implemented by NMFS through permit conditions (e.g., reduced soak times at warmer temperatures or lower DO concentrations, minimal holding or handling time) and additional precautions taken by sturgeon researchers have significantly reduced the lethal and sublethal effects of capture in gill, trammel and trawl nets on Atlantic and shortnose sturgeon. Shortnose sturgeon mortality from capture in research nets has declined over time due to these mitigation measures. Prior to 2005, permitted sturgeon researchers reported 26 shortnose sturgeon killed by capture gear out of 5,909 captured, for a capture mortality rate of 0.44 percent. From 2006 through 2016, researchers reported only two shortnose sturgeon killed by capture gear out of 7,019 captured, for a capture mortality rate of 0.03 percent. Since they were listed in 2012, the mortality rate associated with Atlantic sturgeon capture in scientific research is 0.22 percent (14 killed out of 6,466 captured). This overall mortality rate is inflated by a single incidence of mortality where nine Atlantic sturgeon subadults were reported killed.

Section 10(a)(1)(A) permits are also issued to research facilities and educational display facilities for the captive research and educational display of shortnose and Atlantic sturgeon. Enhancement and scientific research involving captive, or cultured, sturgeon has been identified in the Shortnose Sturgeon Recovery Plan (NMFS 1998) and the Atlantic Sturgeon Status Review (ASSRT 2007b) as important objectives for the recovery of each species. Through the study of captive animals, sturgeon research facilities contribute valuable scientific information about wild fish without negatively affecting wild sturgeon populations, other species, or their habitat. Captive sturgeon research facilities include the USFWS Bears Bluff Fish Technology Center (Wadmalaw Island, South Carolina; Warm Springs, Georgia; Orangeburg, South Carolina; and Welaka, Florida), the USFWS Northeast Fisheries Technology Center (Lamar, PA), Maryland Department of Natural Resources (DNR) Manning Hatchery (Brandywine, Maryland), Maryland DNR Cooperative Oxford Lab (Oxford, Maryland), Maryland DNR Crane Aquaculture Facility (College Park, Maryland), University of Maryland Center of Environmental Science (Cambridge, Maryland), and the NRG Energy Chalk Point Generating Station Aquaculture Center (Aquasco, Maryland). Combined, these facilities currently hold around 10-15 adult shortnose sturgeon, 98 adult Atlantic sturgeon, and 200 juvenile Atlantic sturgeon.

Educational display facilities (e.g., aquariums, zoos, and museums) can also play a role in the conservation and recovery of ESA-listed species by increasing public awareness. There are currently six display facilities with active sturgeon permits: Maritime Aquarium (Norwalk, Connecticut); Virginia Museum (Newport News, Virginia); North Carolina Aquarium (Wilmington, North Carolina); North Carolina Zoo (Asheboro, North Carolina); Springfield Museum (Springfield, Massachusetts); and Riverbanks Zoo (Columbia, South Carolina).

Negative impacts of maintaining cultured shortnose or Atlantic sturgeon at research and educational display facilities are limited to a large degree to the facilities because the captive sturgeon at these facilities are managed as research or display animals with strict quarantine measures. However, because research and display facilities are located typically near or on river systems, there is still a potential for escapement. Potential threats to wild populations resulting from such escapement include genetic alterations, increased competition for space and resources, and transmission of pathogens and diseases.

5.1.10 Global Climate Change

Anthropogenic greenhouse gas emissions have increased tremendously since the pre-industrial era. This increase, driven largely by economic and population growth, has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years (IPCC 2014b). Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming period since the mid-20th century (IPCC 2014b). Average global land and sea surface temperature has increased by 0.85°C (± 0.2) since the late 1800s, with most of the change occurring since the mid-1900s (IPCC 2013; IPCC 2014b). This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley and Berner 2001). The

Intergovernmental Panel on Climate Change (IPCC) estimates that the last 30 years were likely the warmest 30-year period of the last 1,400 years, and that global mean surface temperature change will likely continue to increase in the range of 0.3 to 0.7°C by 2035 (IPCC 2014b).

Climate change is projected to have substantial direct effects on individuals, populations, species, and the community structure and function of marine, coastal, and terrestrial ecosystems in the near future (IPCC 2007; IPCC 2013; McCarty 2001). The direct effects of climate change include increases in atmospheric temperatures, decreases in sea ice, and changes in sea surface temperatures, ocean acidity, patterns of precipitation, and sea level. Indirect effects of climate change include altered reproductive seasons/locations, shifts in migration patterns, reduced distribution and abundance of prey, and changes in the abundance of competitors and/or predators. Climate change will likely have its most pronounced effects on vulnerable species whose populations are already in tenuous positions (Williams et al. 2008). Increasing atmospheric temperatures have already contributed to changes in the quality of freshwater, coastal, and marine ecosystems and to the decline of endangered and threatened species populations (Karl 2009; Mantua et al. 1997).

Global climate change may affect shortnose and Atlantic sturgeon in the future. For example, rising sea level may shift the salt wedge upstream in affected rivers. Shortnose and Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile shortnose and Atlantic sturgeon have limited tolerance to salinity and remain in waters with varying salinity. If the salt wedge moves further upstream, sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. For most spawning rivers, there are no predictions on the timing or extent of any salt wedge shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the salt wedge would eliminate freshwater spawning or rearing habitat, but if habitat is severely restricted, productivity or survivability may decrease.

The increased rainfall predicted in some areas may increase runoff and scour spawning areas, and flooding events could cause temporary water quality issues. Increased extremes in river flow (i.e., periods of flooding and low flow) can alternatively disrupt and fill in spawning habitat that sturgeon rely upon (ISAB 2007). Shortnose and Atlantic sturgeon are uniquely evolved to live in their habitats. Because of this specificity, broad-scale changes in environment, can pose adaptation challenges. Rising temperatures could exacerbate existing water quality problems associated with DO and temperature. Shortnose and Atlantic sturgeon are tolerant to water temperatures up to approximately 28° C; these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise above 28° C in large areas, sturgeon may be excluded from some habitats. In addition, temperature triggers spawning behavior. Warmer water temperatures can initiate spawning earlier in a season for salmon, and the same can be true for sturgeon (ISAB 2007). If water temperatures increase, juvenile sturgeon may experience elevated mortality due to lack of cooler water refuges. If temperature rises beyond thermal limits for extended periods, habitat could be lost; this could be the case if southern habitats warm, resulting in range loss (Lassalle et al. 2010). Apart from direct changes to sturgeon survival, altered water temperatures may alter habitat, including the availability of prey (ISAB 2007).

Some models predict longer and more frequent droughts (and water withdrawal for human use) that may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, shortnose and Atlantic sturgeon may become susceptible to strandings or habitat restrictions. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season, which might affect prey availability for developing sturgeon in rearing habitat. Overall, it is likely that global warming would increase pressures on Atlantic and shortnose sturgeon survival and recovery throughout their ranges.

In the North Atlantic, natural changes primarily concern fluctuations in the North Atlantic Oscillation (NAO), resulting from changes in atmospheric pressure between a semi-permanent high pressure feature over the Azores and a subpolar low pressure area over Iceland (Curry and McCartney 2001; Hurrell 2002; Stenseth et al. 2002). This interaction affects sea surface temperatures, wind patterns, and oceanic circulation in the North Atlantic (Stenseth et al. 2002). The NAO shifts between positive and negative phases, with a positive phase having persisted since 1970 (Hurrell 2002). North Atlantic conditions experienced during positive NAO phases include warmer than average winter weather in central and eastern North America and Europe and colder than average temperatures in Greenland and the Mediterranean Sea (Visbeck 2002). Thus, changes resulting from fluctuations in the NAO may further exacerbate the effects of climate change on ESA-listed species considered in this opinion.

5.2 Description of Major Regional Drainages within the Action Area

This section characterizes the major regional drainages, river basins, and estuarine complexes within the action area, including a description of the general ecology, natural history, past and present human activities and their impacts on aquatic resources. Whereas the section above provided an overview of the coast-wide threats to ESA-listed species, this section provides a more detailed discussion of those threats within each major river basin within the action area. This geographic perspective provides additional context for incorporating the environmental baseline into our analysis of effects of the proposed action on ESA-listed species, DPSs, and individual populations or spawning stocks. As with before, we focus our discussion threats in those areas where sturgeon research primarily occurs (i.e., streams, rivers, riparian areas and estuaries), with a particular emphasis on threats affecting Atlantic and shortnose sturgeon.

5.2.1 Gulf of Maine Drainages

GOM drainages include all of Maine, and parts of New Hampshire, Massachusetts, and the Canadian provinces of New Brunswick and Nova Scotia (Figure 15). This region is strongly influenced by the Labrador Current, which makes the waters significantly colder and more nutrient rich, compared to warmer waters to the south that are more strongly influenced by the Gulf Stream. The GOM has a temperate climate with rocky coastlines characterized by salt marshes, kelp and seagrass beds, tidal mudflats, and underwater rocky outcrops that form the foundation of a complex ecosystem.

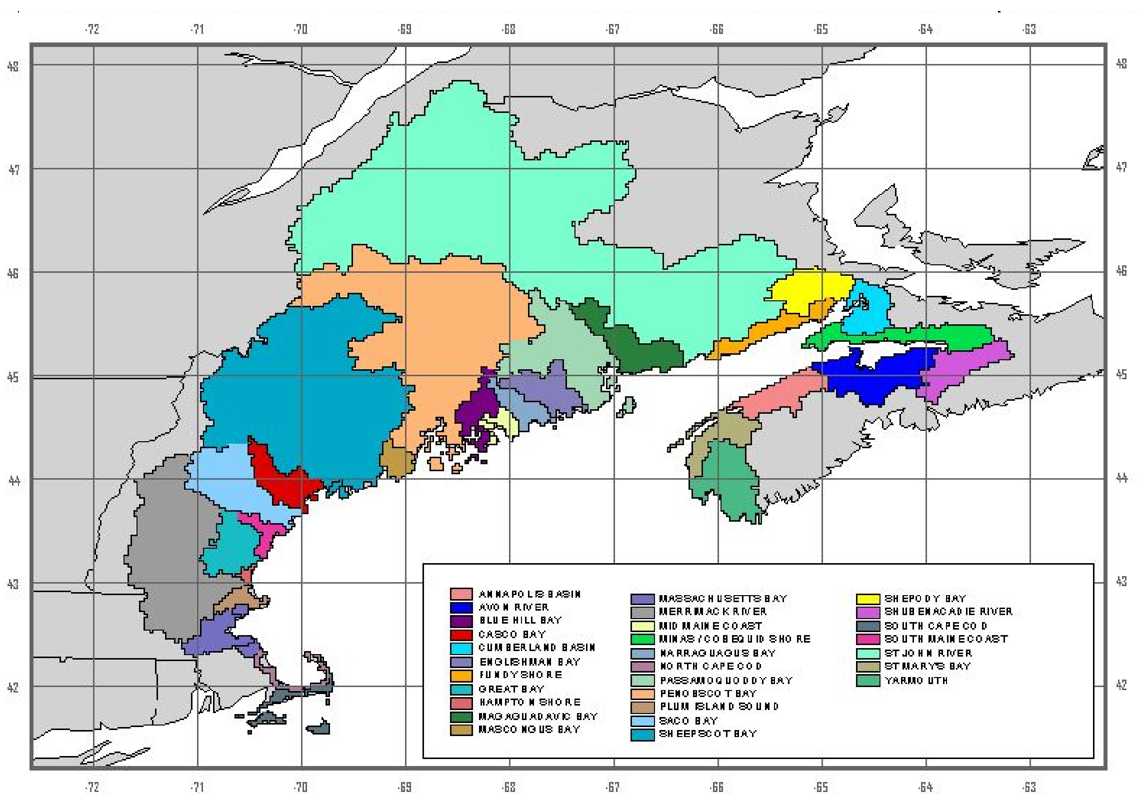

Figure 15. Gulf of Maine watershed basins (Source: EDA/CDW Basins from GOM Land Based Pollution Sources Inventory, NOAA-EPA)

The greater GOM encompasses the Bay of Fundy, Casco Bay, Massachusetts Bay, Merrymeeting Bay and Cape Cod Bay. Estuaries within the GOM were formed by glaciers and as a result have rocky shorelines, shallow soils, and deeply carved channels. USEPA's most recent (2007) National Estuary Program Coastal Condition Report rated water quality as “good” for Massachusetts estuaries (Casco Bay, Massachusetts Bay, and Buzzards Bay) and “fair” for New Hampshire estuaries (USEPA 2007). The water quality index is based on five indicators: dissolved nitrogen, dissolved phosphorous, chlorophyll a, water clarity, and DO However, Massachusetts Bay and Buzzards Bay both received a “poor” rating for sediment toxicity, and Buzzards Bay was also rated “poor” for fish tissue contaminants (USEPA 2007).

Major rivers that drain into the GOM are the St. John, St. Croix, Penobscot, Kennebec, Androscoggin and Merrimack. Most of the watersheds within this region are heavily forested with only a small percent of developed or urban lands. Although developed land covers a relatively small proportion of the GOM drainage, the combined impact of past and on-going industrial operations (i.e., tanneries, metal finishing, pulp and paper mills, mining, textile plants, chemical plants, and municipal sewage) has resulted in degradation of water quality (Chamberland et al. 2002). Contaminants found in regional water bodies include chromium, mercury, nickel, silver, zinc, copper, lead, arsenic, hydrocarbons, dioxins, polycyclic aromatic PAHs and pesticides (Doggett and Sowles 1989; MEDEP 2014). Pulp mills, historically a major industry in Maine, release significant levels of halogenated aromatic hydrocarbons into the water as a byproduct of the chlorine bleaching process that include dioxins. Data collected through Maine's Surface Water Ambient Toxics monitoring program indicate that there is significant contamination by dioxin, PCBs, chlorophenols and heavy metals of the rivers and estuaries within the state (MEDEP 2014). PCB levels of fish sampled in the Androscoggin, Kennebec, Penobscot, Salmon Falls, St. Croix, and Sebasticook Rivers exceed the Maine Center for Disease Control fish tissue action levels for human consumption. The Maine Center for Disease Control has also issued fish consumption advisories for several Aroostook County (northernmost county in Maine adjacent to Penobscot County) rivers and streams due to residual DDT used decades ago.

The Penobscot River watershed, centrally located within the borders of Maine, is the largest watershed in the state with a total drainage area of over 8,570 mi^2 (www.mainerivers.org). The SSSRT identified water quality, dams, and dredging as moderate threats to the Penobscot River shortnose sturgeon population. Sources of water pollution includes coal tar deposits (around Bangor, Maine), municipal water treatment plants, fish hatcheries, industrial waste, and pulp mills (SSSRT 2010). Significant levels of dioxin have been detected in finfish, shellfish, and crustaceans in waters below two Penobscot River paper mills. Fish consumption advisories for mercury are in place for all waters in the Penobscot River basin. There are five major hydroelectric dams along the mainstem of the Penobscot River as well as 111 other licensed dams located along the river and its tributaries (www.mainerivers.org).

The Kennebec River flows 230 miles from its headwaters to the ocean, with a watershed area of 5,384 mi^2 (Jackson et al. 2005)(www.mainerivers.org). Land use in the Kennebec River watershed is 82 percent forest, 6 percent agriculture, 10 percent water and 2 percent developed

(Jackson et al. 2005). The SSSRT identified water quality and dredging as moderate threats to the Kennebec River shortnose sturgeon population (SSSRT 2010). Water quality in the Kennebec River basin was negatively impacted by industrialization in the early to mid-20th century. Pollution effects in the lower river were chronic and acute leading to massive fish kills and reported outbreaks of waterborne diseases from its use as a water supply. Mercury, PCBs, and dioxin levels remain high (SSSRT 2010). The Kennebec River has eight major hydroelectric dams on its mainstem, which restrict both upstream and downstream fish passage. In 1999, the Edwards Dam was removed, opening 17 additional miles of historical spawning habitat for Atlantic and shortnose sturgeon. DO levels and macroinvertebrate population densities have improved since removal of Edwards Dam.

The Androscoggin River flows 164 miles, with a watershed of 3,263 mi^2 (Jackson et al. 2005)(www.mainerivers.org). Land use in the Androscoggin River watershed is 86 percent forested, 5 percent agriculture, 7 percent water, and 2 percent developed (Jackson et al. 2005). Large pulp and paper mills were built on the Androscoggin in the early 20th century. By the 1960s, the Androscoggin River had become one of the most severely polluted rivers in the United States. DO levels from Berlin, New Hampshire, to Brunswick, Maine, frequently reached zero during the summer, resulting in the death of nearly all fish and other aquatic life in that stretch of the river. Fourteen hydroelectric dams on the mainstem of the Androscoggin River exacerbated the effects of industrial pollution on the water quality of the river (Jackson et al. 2005).

The Merrimack River is 180 miles long, with 16 sub-basins in a watershed of 5,014 mi^2 (Jackson et al. 2005). The Merrimack River watershed is composed of 75 percent forest, 13 percent urban, 6 percent agriculture, 5 percent surface water, and 1 percent other (Jackson et al. 2005). Seventy five percent of the watershed is in New Hampshire, with the rest in northeast Massachusetts. The lower stretches of the Merrimack River Basin (last 9 miles), extending north into New Hampshire and south to Cape Ann, Massachusetts, include 25,000 acres of estuarine habitat and 15,000 acres of salt marsh habitat, which is referred to as the Great Marsh (USACE 2003). The Merrimack River flows through the industrial centers of Manchester and Concord, New Hampshire, and Lowell and Lawrence, Massachusetts. The main sources of pollution in the Merrimack river are combined sewage overflows, industrial discharge, urbanization and its associated run-off (USACE 2003). The upper mainstem of the Merrimack River has problems with bacteria, *E. coli*, and acidity, while the lower mainstem has problems with bacteria, metals, nutrients, dioxins, turbidity and suspended solids, and un-ionized ammonia. DO concentrations are below minimum thresholds during periods of drought or low flow (SSSRT 2010). In all, over 125 miles of mostly lower watershed areas do not support their designated uses (USACE 2003). The Merrimack River watershed has over 500 dams, including major impoundments that essentially turn the river's mainstem into a series of ponds (Jackson et al. 2005). Flow alteration is considered a problem on the upper mainstem of the river and has resulted in the river not meeting USEPA's flow requirements (USACE 2003).

5.2.2 Long Island Sound and Connecticut River Drainages

The Long Island Sound (LIS) drainage area includes portions of Connecticut, New York, Massachusetts, New Hampshire, Rhode Island and Vermont (Figure 16). The LIS estuary connects to the Atlantic Ocean on both the eastern side ("the Race") and western side (the East River). Salinities range from 23 ppt in the western end to 35 ppt on the eastern end. The surface area of the LIS is 1,320 mi^2, draining an area of over 16,000 mi^2 (Jackson et al. 2005). With over eight million people living in the LIS watershed, both point and non-point source pollution are major concerns. The LIS has elevated levels of PCBs, PAHs, nitrogen, lead, mercury, cadmium, cesium, zinc, copper, and arsenic. Hypoxia is a common occurrence in LIS bottom waters during the late summer. In 2001 a nitrogen Total Maximum Daily Load (TMDL) was established for the LIS to help meet CWA water quality standards. The goal was to reduce nitrogen discharges by 58.5 percent from Connecticut and New York. USEPA's most recent (2007) National Estuary Program Coastal Condition Report rated overall water quality as "fair" for the LIS (USEPA 2007). By individual indicator, dissolved nitrogen, chlorophyll a, and water clarity were rated "good" but dissolved phosphorous and DO were rated as "fair." The LIS also received a "poor" rating for sediment quality (toxicity and contaminants), benthic index, and fish tissue contaminants (USEPA 2007).

The predominant river within this basin is the Connecticut, which drains a watershed of 11,259 mi^2 and flows approximately 410 miles from the highlands of Quebec and New Hampshire to its mouth. The lower 56 miles of the Connecticut River is a tidal estuary. The Connecticut River's bed is composed of glacial deposits and granitic bedrock. At the mouth, the average discharge is 10.2 billion gallons per day, which accounts for approximately 70 percent of the freshwater inflow to the LIS (Jackson et al. 2005). The dominant land use within the Connecticut River watershed is forest (80 percent), followed by agriculture (11 percent), and other mixed uses (9 percent) (Jackson et al. 2005). Major population centers in the Connecticut watershed are Holyoke and Springfield, Massachusetts and Hartford, Connecticut. The human population density in the watershed is approximately 179 people per square mile (Jackson et al. 2005). Throughout the 20th century, power plants, defense contractors, municipalities, and major corporations (e.g., General Electric, Union Carbide, and Pfizer) contributed large quantities of pollutants to the river. While water quality has improved since the enactment of the CWA, chromium, copper, nickel, lead, mercury, and zinc, chlordane, DDT, DDE, PCBs, and PAHs are still found in quantities above the USEPA recommended levels in sediments and fish tissue throughout the watershed (Jackson et al. 2005). The SSSRT identified water quality as a moderate threat to the Connecticut River shortnose sturgeon population (SSSRT 2010). High levels of mercury and PCBs have been found in finfish tissues and coal tar deposits are documented below Holyoke Dam.

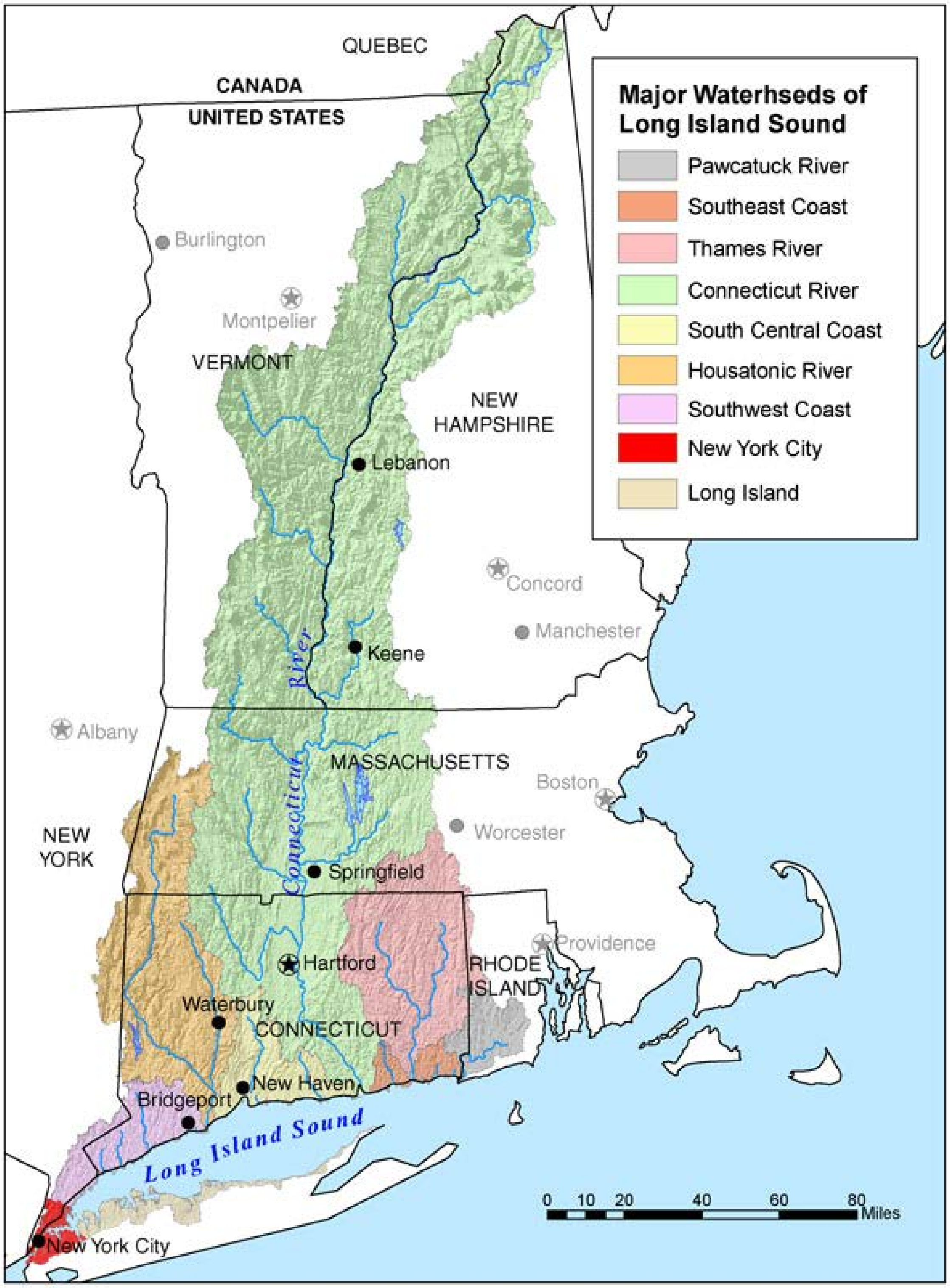

Figure 16. Major watersheds of the Long Island Sound (Source: USGS Connecticut River Watershed Atlas, URL: http://nh.water.usgs.gov/project/ct_atlas/n_model.htm).

Dams represent a major stressor on sturgeon habitat in the Connecticut River (SSSRT 2010). The Connecticut River has 16 hydroelectric dams on its mainstem and an estimated 900 smaller dams throughout the watershed. Sturgeon are separated into upstream and downstream segments by the Holyoke Dam (rkm 140), which bisects upstream spawning habitat from downstream feeding habitat in the estuary. Fish passage through the Holyoke Dam and industrial canal system is lethal for many adults. Hydropower operations close to the Montague shortnose sturgeon spawning area, including the artificial manipulation of critical spawning habitat (disruption of natural flows, dewatering, and torrential releases), likely impede spawning and recruitment success (SSSRT 2010).

5.2.3 Hudson River Basin

The Hudson River flows from the Adirondack Mountains approximately 315 miles to the ocean, draining a watershed area of 13,365 mi^2 (Figure 17). At the mouth the average discharge is 13.5 billion gallons per day (Jackson et al. 2005). The Hudson is a freshwater tidal estuary between Troy, New York (rkm 248) and Newburgh Bay (rkm 100), and then turns into a tidal brackish estuary for the lower 62 miles to the Atlantic Ocean (Jackson et al. 2005). Hudson River watershed land use is 25 percent agriculture, 65 percent forested, 8 percent urban, and 5 percent other (Jackson et al. 2005). The average human population density in the watershed is approximately 350 people per square mile (Jackson et al. 2005), with the majority of people living within or nearby the major population centers of New York City, Albany, Poughkeepsie, and Hudson, New York, and Jersey City, New Jersey.

Throughout the 20th century, power plants, municipalities, pulp and paper mills, and major corporations (e.g., IBM, General Motors) contributed large quantities of pollutants into the Hudson River. USEPA estimates that over a 30-year period ending in the late 1970s, an estimated 1.3 million pounds of PCBs entered the river from two General Electric capacitor manufacturing plants located in Fort Edward and Hudson Falls, New York. PCBs have contaminated the sediments, surface water, groundwater, wildlife, and floodplain soils of the Hudson River. In 1984, approximately 200 miles of the Hudson River, from Hudson Falls to New York City, were designated as a PCB Superfund site. A clean-up project that began in 2009 calls for targeted environmental dredging by General Electric of approximately 2.65 million cubic yards of PCB-contaminated sediment from a 40-mile section of the upper Hudson River (USEPA 2015). USEPA's most recent (2007) National Estuary Program Coastal Condition Report rated overall water quality at the mouth of the Hudson river (i.e., New York-New Jersey harbor estuary) as "poor," due to high levels of phosphorous (rated "poor) and nitrogen (rated "fair") (USEPA 2007). The New York-New Jersey harbor also received a "poor" rating for sediment quality (toxicity and contaminants), benthic index, and fish tissue contaminants (USEPA 2007). The SSSRT identified water quality as a moderate threat to the Hudson River shortnose sturgeon population due to the presence of contaminants (heavy metals, PCBs, dioxins) in sturgeon tissue and temporary sediment loading during spring runoff (SSSRT 2010).

Figure 17. Hudson River watershed (Source: New York State Department of Environmental Conservation).

The Hudson River is a major transportation and freight corridor for much of the northeastern United States (Everly and Boreman 1999). A dredged shipping channel maintains an open corridor for large commercial vessels to reach the Port of Albany (rkm 232). Along the lower Hudson River (Troy to New York City), the shipping channel maintains a depth of approximately 35 feet, while in other parts of the river the channel depth is as great as 60 feet (Levinton and Waldman 2006). Dredging is identified as a moderate threat to shortnose sturgeon as maintenance dredging occurs in areas of known spawning and foraging within the Hudson

River; however dredging occurs when sturgeon are not present in the area (SSSRT 2010). The large volume of shipping traffic in the Hudson results in detrimental effects to ESA-listed sturgeon populations due to disruption of benthos and habitat, ship strikes, and the introduction of contaminants. The mainstem Hudson River has 14 main dams and there are several flood control dams near the mouths of many tributaries that have drastically altered mainstem flow dynamics. The lower 248 rkm are unobstructed from dams, which makes the Hudson a particularly important river for anadromous fishes, including ESA-listed shortnose sturgeon and Atlantic sturgeon.

5.2.4 Delaware River Basin

The Delaware River basin contains approximately 13,539 mi^2, draining parts of Pennsylvania (6,422 mi^2); New Jersey (2,969 mi^2); New York (2,362 mi^2); and Delaware (1,004 mi^2) (Delaware River Basin Commission web site: http://www.state.nj.us/drbc/) (Figure 18). Included in the total basin area is the 782 mi^2 Delaware Bay, which sits roughly half in New Jersey and Jersey, and extends downstream for 144 miles (Jackson et al. 2005). At the mouth, the average discharge is 9.6 billion gallons per day (Jackson et al. 2005). The Delaware River watershed usage is 24 percent agriculture, 60 percent forested, 9 percent urban, and 7 percent surface water or other (Jackson et al. 2005). Population centers in the Delaware River watershed include Easton, Allentown, Reading, and Philadelphia, Pennsylvania; Trenton and Camden, New Jersey; and Wilmington, Delaware. The human population density in the watershed is approximately 555 people per mi^2 (Jackson et al. 2005).

Power plants, municipalities, pulp and paper mills, and industries such as the Philadelphia Shipyard, Bethlehem Steel, and New Jersey Zinc Company have all contributed large quantities of pollutants to the Delaware River over the past two centuries. Pollution is identified as a major factor contributing to sharp declines in migratory fish populations, including ESA-listed sturgeon species, within the region. In 1967, the Delaware River Basin Commission (DRBC), a federal-interstate agency, adopted the most comprehensive water quality standards of any interstate river basin in the nation. The standards were tied to an innovative waste load allocation program, which factored in the waste assimilative capacity of the tidal Delaware River. The DRBC waste load allocation program was an early predecessor of TMDLs that are now widely used to meet USEPA CWA water quality standards (DRBC web site: http://www.state.nj.us/drbc/). By the late

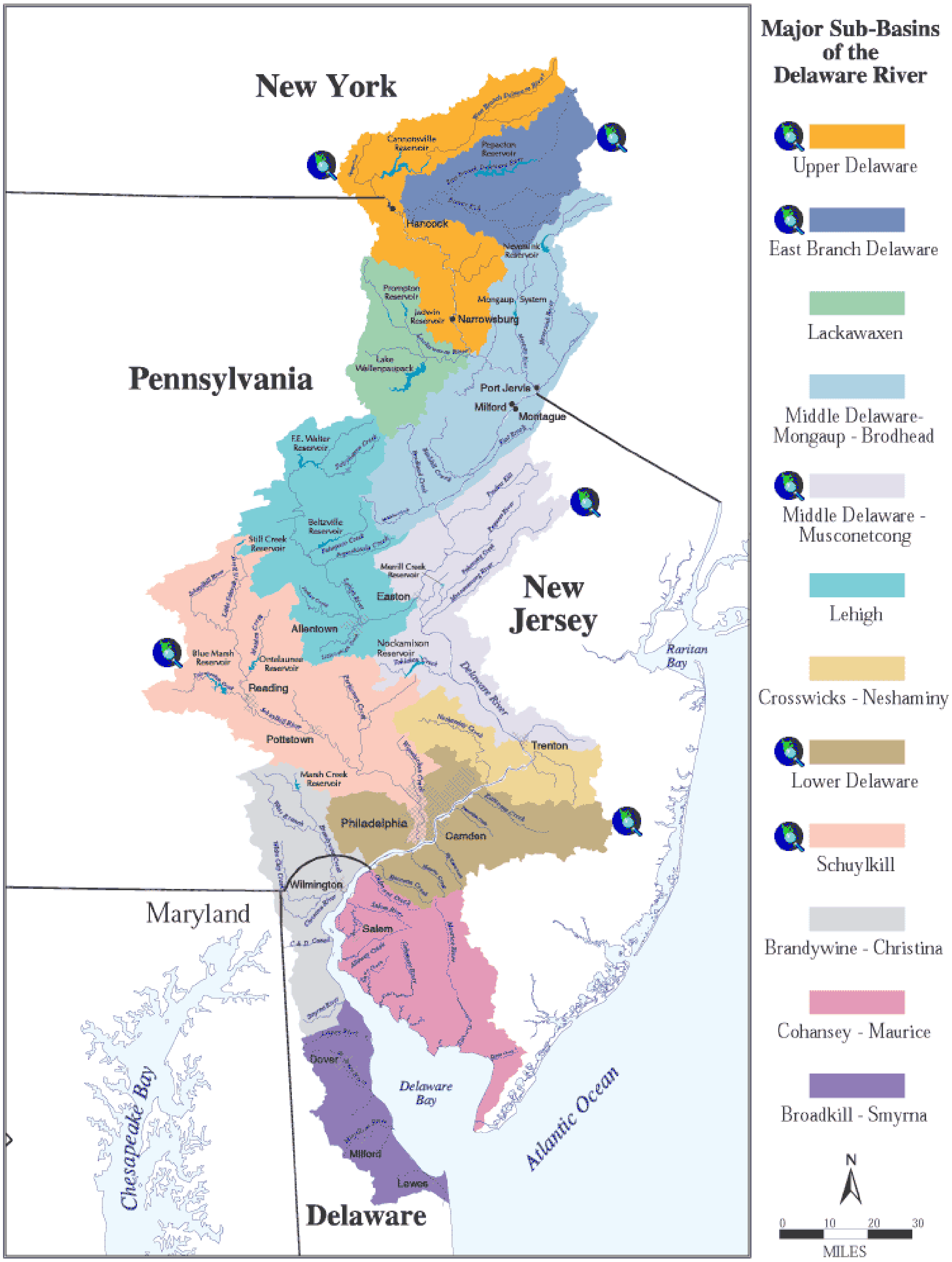

Figure 18. Major sub-basins of the Delaware River (Source: Delaware River Basin Commission)

1980s, over one billion dollars was spent on improving wastewater treatment facilities in the Delaware River Basin. DRBC began its Delaware Estuary Toxics Management Program in 1989, designed to develop methods to control the discharge of toxic pollution from wastewater treatment plants into the estuary. New rules, stemming from this program, were adopted in 1996 that added many toxic substances to what was originally regulated in Delaware River wastewater treatment plant discharge (DRBC web site: http://www.state.nj.us/drbc/). Despite significant cleanup efforts, overall water quality for the Delaware estuary was rated as “poor” in USEPA’s most recent (2007) National Estuary Program Coastal Condition Report rated (USEPA 2007). By individual indicator, dissolved nitrogen was rated “poor”; dissolved phosphorous chlorophyll a, and water clarity were rated “fair”; and DO was rated “good.” The LIS also received a “poor” rating for sediment quality (toxicity and contaminants), benthic index, and fish tissue contaminants (USEPA 2007). The SSSRT identified water quality as a moderately high threat to the Delaware River shortnose sturgeon population due to the detection of mercury, cadmium, and endocrine disrupting chemicals (e.g., PCDD’s/TCDF’s, DDE, and PCB’s) in shortnose sturgeon tissue samples (SSSRT 2010). Endocrine disrupting chemicals have been linked to reduced fish fecundity and egg viability, increased early life stage mortality, anatomical defects in larvae, and other conditions.

The Delaware River is an important commercial and recreational waterway that requires periodic dredging. Approximately 3,000 cargo vessels transit the Delaware River annually as well as numerous smaller commercial and recreational vessels. Maintenance dredging in known nursery, foraging and wintering areas is identified as a moderately high threat to sturgeon populations in the Delaware (SSSRT 2010). Although dredging is restricted seasonally to minimize effects on anadromous species, this activity still represents a threat to sturgeon. The deepening of the Delaware River Philadelphia to Trenton Federal Navigation Channel has caused shortnose sturgeon mortality in the past and may have affected shortnose sturgeon distribution and foraging habitat (USACE 2009). In mid-March 1996, three subadult shortnose sturgeon were found in a dredge discharge pool on Money Island, near Newbold Island. In January 1998, three shortnose sturgeon were discovered in the hydraulic maintenance dredge spoil in the Florence to Trenton section of the upper Delaware River. Since 1998, the U.S. Army Corps of Engineers has been avoiding dredging in the overwintering area during the time of year when sturgeon are present. As discussed above (Section 5.1.8 Ship Strikes), vessel strikes also pose a significant threat to ESA-listed Atlantic sturgeon in the Delaware River.

Sturgeon are also susceptible to effects of cooling water intake operations at power plants located in the Delaware Bay. The SSSRT identified impingement/entrainment as a moderately high sources of stress on the shortnose sturgeon population in the Delaware River (SSSRT 2010). Larvae have been reported from intakes at the Mercer Generating Station, Fairless Hills, and near water treatment plant intakes at Trenton and Morrisville. The Mercer Generating Station is scheduled to be de-commissioned in 2017. Public Service Enterprise Group Nuclear operates two nuclear power plants pursuant to licenses issued by the U.S. Nuclear Regulatory Commission on the Delaware River: Salem and Hope Creek generating stations, located at rkm 80 and 81, respectively. Consultation pursuant to section 7 of the ESA between the Nuclear Regulatory Commission and NMFS on the effects of the operation of these facilities on ESA-listed sturgeon and sea turtles has been ongoing since 1979. The most recent Biological Opinion was issued on July 17, 2014 (NMFS 2014). Salem Unit 1 will cease operations in 2036 and Salem Unit 2 will cease operations in 2040. Hope Creek is authorized to operate until 2046.

Bycatch from the shad commercial gillnet fishery and from recreational anglers is also considered a moderate threat to shortnose sturgeon in the Delaware River (SSSRT 2010). The Delaware River has 16 dams in its headwaters, but the middle and lower portions are free-flowing and represent the longest undammed stretch of river east of the Mississippi. This stretch of free-flowing river makes the Delaware a particularly important river for anadromous fishes, including ESA-listed shortnose sturgeon and Atlantic sturgeon.

5.2.5 Chesapeake Bay Watershed

The Chesapeake Bay watershed spans more than 64,000 square miles and encompasses parts of six states—Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia—and the entire District of Columbia (Chesapeake Bay 2015) (Figure 19). Chesapeake Bay is the largest estuary in the United States stretching some 200 miles from Havre de Grace, Maryland, to Norfolk, Virginia, with more than 11,000 miles of shoreline. Chesapeake Bay lies totally within the Atlantic Coastal Plain but the watershed includes parts of the Piedmont Province and the Appalachian Province. Because it is relatively shallow, just over 6m on average, the Chesapeake is rapidly flushed by tidal currents and freshwater inputs from more than 100 rivers and thousands of tributary streams (Goetz et al. 2004). The Chesapeake's three largest rivers (Susquehanna, Potomac and James), which provide more than 80 percent of the freshwater entering the Bay, are described in more detail below. These freshwater sources also introduce tremendous loads of a wide variety of toxic pollutants, nutrients and sediments, byproducts of the nearly 18 million people that live within this watershed. Between 2011 and 2013, 29 percent of the water quality standards for DO, water clarity, underwater grasses and chlorophyll a in the Bay and its tidal rivers were met (Chesapeake Bay 2015). The Susquehanna River alone delivers about half of the freshwater input to the Bay, along with nearly 100 million metric tons of sediment, tens of thousands of tons of nitrogen, and thousands of tons of toxic pollutants on an annual basis (Goetz et al. 2004). Inputs of this magnitude adversely affect the physical properties of the estuary including water clarity, DO concentrations, temperature and salinity gradients; as well as biological components ranging from phytoplankton densities, aquatic vegetation habitat, and trophic structures. The greatest share (~40 percent) of excess nutrient pollutants are introduced to the Bay through agricultural practices (Goetz et al. 2004). Other substantial non-point sources of nutrients and toxics introduced to the Bay originate in urban or suburban areas, including the transportation network, through stormwater runoff. Coal mining has also had a

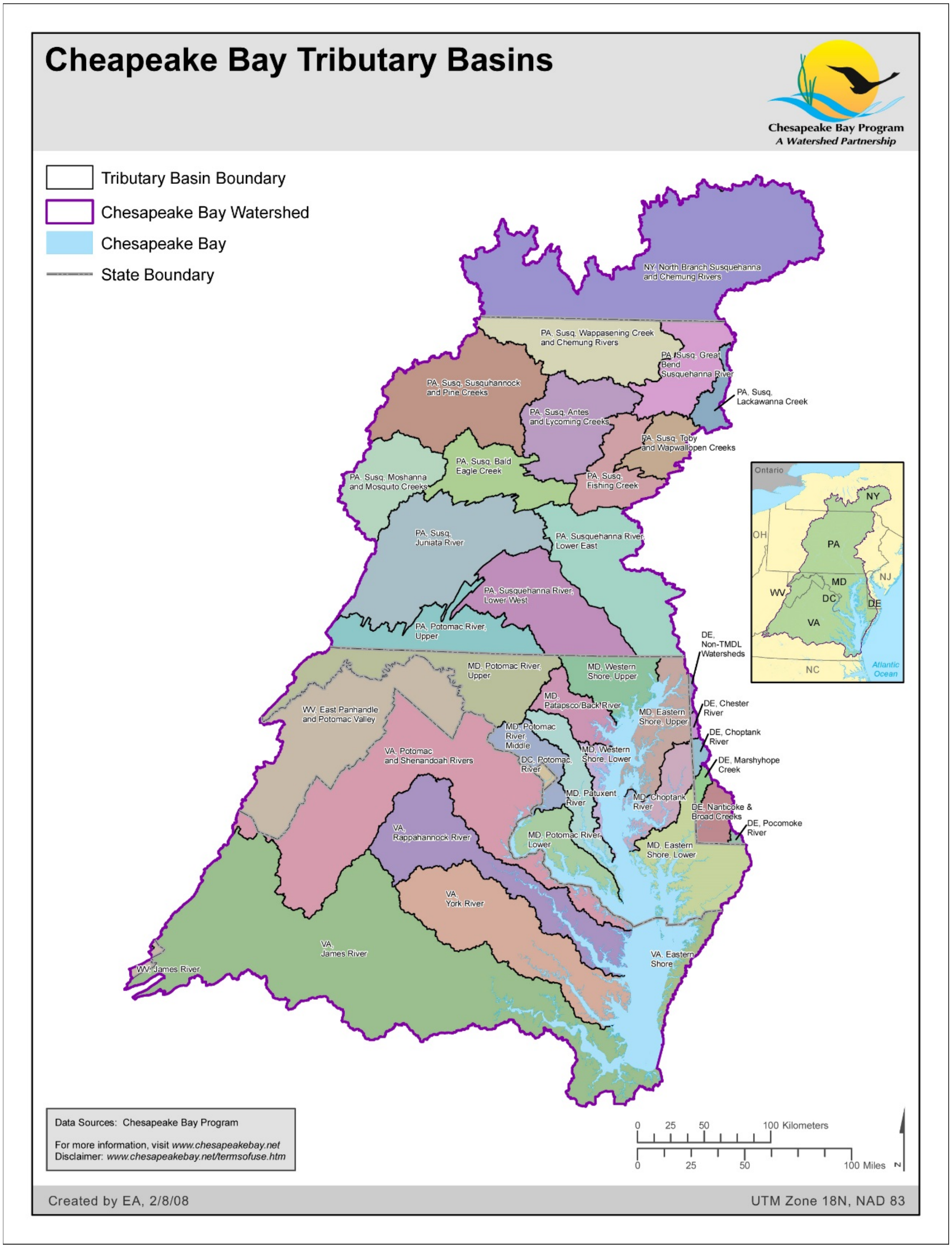

Figure 19. Map of the Chesapeake Bay watershed (Source: Chesapeake Bay Program, www.chesapeakebay.net).

significant impact on water quality in the Chesapeake watershed. Abandoned coal mines in the Appalachian Mountain chain leach sulfuric acid into tributaries of the Chesapeake Bay and must be treated with doses of limestone to balance the pH of the water draining from the mines. While many of these old mines have been reclaimed, it may take decades or more to completely reclaim all of the mines leaching into the watershed.

Water quality in the Bay has improved somewhat in recent years due to a combination of efforts including improved regulatory controls on point source pollution, habitat restoration projects, wastewater treatment plant upgrades, and implementation of agricultural best management practices. Between 2009 and 2013, nitrogen loads to the Bay fell by an estimated seven percent, phosphorous loads fell eleven percent, and sediment loads fell six percent (Chesapeake Bay 2015). Chesapeake Bay still faces some major challenges including biological “dead zones,” pathogen outbreaks (e.g., the dinoflagellate *Pfiesteria*), increased rates of freshwater wetland loss, and declines in traditional fisheries production such as menhaden and crabs (Goetz et al. 2004). Due to insufficient progress and poor water quality in the Chesapeake Bay and its tidal tributaries, a CWA TMDL was established by the USEPA in December 2010. The TMDL set Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year (USEPA 2010). This equates to a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The overall Chesapeake Bay TMDL is comprised of 92 smaller TMDLs for individual tidal segments.

The Susquehanna River flows approximately 448 miles from upstate New York to Havre de Grace, Maryland, and drains a watershed area of 27,580 mi^2 (Jackson et al. 2005). The river, which serves as the primary freshwater source of the Chesapeake Bay, discharges on average 26.3 billion gallons per day (Jackson et al. 2005). The Susquehanna is not tidally influenced and does not have much estuary habitat. The Susquehanna River watershed usage is 20 percent agriculture, 63 percent forested, 9 percent urban, and 7 percent pasture (Jackson et al. 2005). The human population density in the watershed is approximately 145 people per square mile.

Past activities that had the greatest cumulative impact on the Susquehanna River’s health include logging, dam building, and coal mining. Coal is no longer a primary industry in the watershed, but the impacts of the acid mine drainage are still prominent. Another major problem in the Susquehanna has been untreated sewage and industrial waste dumped directly into the river. Due to continued point and non-point sources of pollution, the Susquehanna contributes 44 percent of the nitrogen and 21 percent of the phosphorous entering the Chesapeake Bay. Data from the USGS non-tidal River Input Monitoring station at Conowingo, Maryland, indicate an improvement in total nitrogen load from the Susquehanna over the past 30 years (1985-2014) but a degradation in terms of phosphorous and suspended sediment loading over the same period (Moyer and Blomquist 2016) (Table 16). Elevated levels of copper, sulfur, selenium, arsenic, cobalt, chromium, lead, mercury, zinc, and pesticides are also still considered a problem within the Susquehanna watershed (Beyer and Day 2004). The SSSRT identified water quality as a moderate threat to the shortnose sturgeon population in the Susquehanna due primarily to nutrient enrichment and habitat alteration, metals and low pH levels due to acid mine drainage and elevated levels of dissolved solids, PCBs, PAHs, and HOCs (SSSRT 2010).

Table 16. Summary of long-term (1985-2014) and short-term (2005-2014) trends in nitrogen, phosphorus, and suspended- sediment loads for the River Input Monitoring stations (Moyer and Blomquist 2016).

Monitoring station	Total nitrogen load		Total phosphorus load		Suspended-sediment load	
	Long term	Short term	Long term	Short term	Long term	Short term
SUSQUEHANNA RIVER AT CONOWINGO, MD	Improving	No trend	Degrading	Degrading	Degrading	No trend
POTOMAC RIVER AT WASHINGTON, DC	Improving	Improving	Improving	Improving	Improving	Improving
JAMES RIVER AT CARTERSVILLE, VA	Improving	No trend	Improving	Degrading	Degrading	Degrading
RAPPAHANNOCK RIVER NR FREDERICKSBURG, VA	Improving	Improving	No trend	No trend	No trend	Improving
APPOMATTOX RIVER AT MATOACA, VA	Improving	Degrading	Degrading	Degrading	No trend	Degrading
PAMUNKEY RIVER NEAR HANOVER, VA	No trend	Degrading	Degrading	No trend	Degrading	Degrading
MATTAPONI RIVER NEAR BEULAHVILLE, VA	Improving	Degrading	Improving	No trend	Improving	Improving
PATUXENT RIVER NEAR BOWIE, MD	Improving	Improving	Improving	Improving	Improving	Degrading
CHOPTANK RIVER NEAR GREENSBORO, MD	Degrading	Degrading	Degrading	Degrading	Improving	Degrading

Dams are considered a major stressor on sturgeon populations in the Susquehanna River (SSSRT 2010). The Susquehanna River has four major dams on the mainstem, the first of which is the Conowingo Dam which was built in 1928 and is located just 10 miles upstream of the river's mouth. The Conowingo Dam traps polluted sediments within its 14 mile long, 9,000-acre reservoir, which are discharged downstream into the Chesapeake Bay during periods of flooding and major storm events.

The Potomac River begins in the Allegheny Mountains of West Virginia and flows approximately 383 miles to the western side of the Chesapeake Bay. At its mouth, the average discharge is 7.3 billion gallons per day (Jackson et al. 2005). The Potomac watershed covers an area of 14,670 mi^2. The Potomac River estuary extends for 117 miles from its mouth at Pt. Lookout on the Maryland side and Smith Point on the Virginia side, to its head-of-tide located approximately 0.4 miles upstream of Chain Bridge in the District of Columbia. The Potomac River watershed usage is 32 percent agriculture, 58 percent forested, 5 percent urban, 4 percent water, 1 percent wetland, and 1 percent barren (Jackson et al. 2005). Major population centers along the Potomac River watershed include Washington, D.C.; Arlington and Alexandria, Virginia; and Hagerstown, Maryland. The human population density within the watershed is approximately 358 people per square mile (Jackson et al. 2005).

Similar to the Susquehanna, discharge of polluted sediment and nutrients from the Potomac River has a significant impact on the water quality in Chesapeake Bay. The Maryland Department of the Environment identified the waters of the Potomac River watershed (lower, middle, and upper tidal sections) on the State's CWA 303(d) list as impaired by nutrients (1996), sediments (1996), toxics (PCBs in fish tissue; 2002), and impacts to biological communities (2004 and 2006) (MDE 2006). TMDLs for the Potomac have been prepared for fecal coliform and PCBs. The middle tidal section was listed as impaired for metals (cadmium, chromium, copper, and lead) in 1996. A Water Quality Analysis for cadmium, chromium, copper, and lead to address the 1996 metals listing was approved by the USEPA in 2006. Levels of nitrogen, phosphorus, and sediment have been decreasing in the Potomac River since 1985 as pollution from agriculture, wastewater treatment plants, and point sources is on the decline (Table 4). Wastewater treatment plant discharges are a primary source of pollution to the Potomac River. At present, 95 percent of the 104 plants on the Potomac have set limits that meet the USEPA's standards for emissions (source: http://potomacreportcard.org/pollution/). Water quality is considered the greatest threat to shortnose sturgeon in the Potomac due to contaminated sediments, PCBs, debris and nitrogen runoff, low DO concentrations, seasonal algae blooms, and fish kills (SSSRT 2010). The SSSRT also identified maintenance dredging, bycatch (i.e., commercial pound nets), and impingement/entrainment (i.e., municipal water withdrawals and power plant intakes) as moderate threats to sturgeon in the Potomac River.

The James River begins in the Allegheny Mountains and flows 340 miles across Virginia to the Chesapeake Bay. At its mouth, the average discharge is 6.5 billion gallons per day (Jackson et al. 2005). The James River estuary begins at the fall line in Richmond, Virginia. The James River drains a watershed area of 10, 432 mi^2 which is 23 percent agriculture, 71 percent forested, and 6 percent urban. Population centers within the watershed include Charlottesville, Richmond, Petersburg, and Hampton Roads, Virginia. The human population in the watershed is approximately 2.5 million people, or approximately 240 people per square mile (Jackson et al. 2005). The James River has 21 municipal dischargers permitted and 28 permitted industrial dischargers. There are also 18 USEPA Superfund sites along the river, mostly found in the major cities along its corridor. Data from the USGS non-tidal River Input Monitoring station in Cartersville, Virginia indicate long-term (1985-2014) improvements in total nitrogen and phosphorous loads from the James but a long-term degradation in suspended sediment loading over the same period.

5.2.6 Southeast Atlantic Region

The Southeast Atlantic region covers all the drainages that ultimately drain to the Atlantic Ocean between the states of North Carolina and Florida. The region contains more than 22 river systems that generally flow in a southeasterly direction to the Atlantic Coast. The diverse geology and climate ensures variability in biological productivity and hydrology. Major basins include the Albemarle-Pamlico Watershed and its tributaries, the Cape Fear River, Winyah Bay and the

Santee-Cooper Systems, the Savannah, Ogeechee, and the St. Johns River. The more northerly rivers, such as the Roanoke which is part of the Albemarle-Pamlico watershed, are cooler, have a higher gradient, and streambeds largely characterized by cobble, gravel and bedrock (Smock et al. 2005). The more southern rivers within this region are characterized by larger portions of low gradient reaches, streambeds composed of greater amounts of sand and fine sediments, high suspended solids, and neutral to slightly acidic waters with high concentrations of dissolved organic carbon. Rivers emanating entirely within the Coastal Plain are acidic, low alkalinity, blackwater systems with dissolved organic carbon concentrations often up to 50 mg/L (Smock et al. 2005).

5.2.6.1 Albemarle-Pamlico Sound Complex

The Albemarle-Pamlico Sound Estuarine complex, the largest lagoonal estuarine system in the United States, is comprised of seven sounds including Currituck Sound, Albemarle Sound, Pamlico Sound and others (USEPA 2006)(Figure 20). The Estuarine Complex is separated from the Atlantic Ocean by the Outer Banks, a long barrier peninsula characterized by shallow waters and wind-driven tides that result in variable patterns of water circulation and salinity. Estuarine habitats include salt marshes, hardwood swamp forests, and bald cypress swamps. The geology of the Albemarle-Pamlico watershed basin strongly influences the water quality and quantity within the basin. More than half of the water flowing in streams discharging to the Albemarle-Pamlico Estuarine complex comes from ground water. The headwaters of the basin tributaries are generally steep and surface water flowing downstream has less opportunity to pick up dissolved minerals. Water velocity slows due to the low gradient as water flows reach the Piedmont and Coastal Plain, and streams generally pick up two to three times the mineral content of surface waters in the mountains (Spruill et al. 1998). Primary freshwater inputs to the estuarine complex include the Pasquotank, Chowan and Roanoke Rivers that flow into Albemarle Sound, and the Tar-Pamlico and Neuse Rivers that flow into Pamlico Sound.

Throughout the 20th century, mining, agriculture, paper and pulp mills, and municipalities contributed large quantities of pollutants to the Albemarle-Pamlico estuarine complex. Enhanced runoff of nutrients in the spring has been a major contributor to nuisance harmful algal blooms (HABs) (USEPA 2006). Water quality monitoring data from 1945 to 1988 for this estuarine complex indicate a long-term trend of increased DO levels, increased pH, decreased suspended solids, and increased chlorophyll a levels (USEPA 2006). The condition of the Albemarle-Pamlico estuarine complex, was rated “good to fair” in the most recent USEPA National Estuary Coastal Condition Report (USEPA 2006). This overall condition was based on four indices combined: water quality, sediment quality, benthic index, and fish tissue contaminants. More than half (61 percent) of the Albemarle-Pamlico estuarine area was rated as “good” for water quality index, with 35 percent rated as “fair” water quality and 4 percent rated as “poor” water quality (USEPA 2006). The water quality index was based on five indicators: dissolved nitrogen, dissolved phosphorous, chlorophyll a, water clarity, and DO The Albemarle-Pamlico estuarine complex was rated as “good” for nitrogen, phosphorous, and water clarity but “fair” for DO and chlorophyll a (USEPA 2006). The fish tissue contaminants index for the Albemarle-Pamlico estuary is rated as “good to fair.” Fish tissue sampled within the complex showed elevated concentrations of total PAHs and total PCBs with 10 percent of the sampled stations exceeding risk-based USEPA Advisory Guidance values (USEPA 2006).

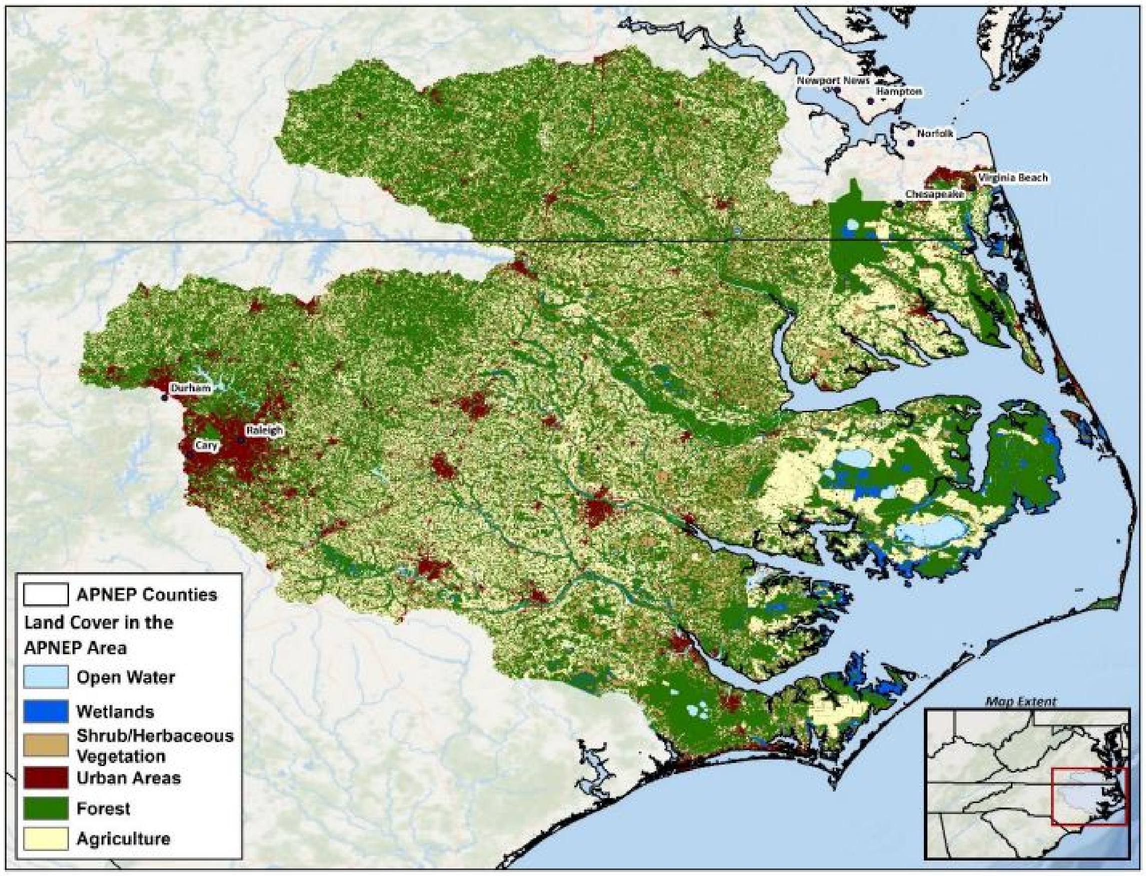

Figure 20. Land use and land cover in the Albemarle-Pamlico watershed (Source: RTI International).

The Roanoke River is approximately 410 miles long and drains a watershed of 9,580 mi^2. The Roanoke River begins in the mountains of western Virginia and flows across the North Carolina border before entering the Albemarle Sound. At the mouth, the average discharge is 5.3 billion gallons per day (Smock et al. 2005). Land use in the Roanoke watershed is dominated by forest (68 percent) and agriculture (25 percent), with only 3 percent urban or developed (Smock et al. 2005). The only major population center in the watershed is Roanoke, Virginia. The population density in the watershed is approximately 80 people per square mile (Smock et al. 2005). The SSSRT identified dams, water quality and bycatch in pound nets all as moderate threats to shortnose sturgeon in the Roanoke River (SSSRT 2010). Three upstream dams (from rkm 220 to 288) affect sturgeon habitat and migration. Degradation of water quality affecting Roanoke River sturgeon include low DO concentrations in summer months, bank erosion nearby spawning grounds, elevated levels of dioxins and mercury, and large water withdrawals (SSSRT 2010).

The Neuse River Estuary is the major southern tributary of North Carolina’s Pamlico Sound. The Neuse River flows 248 miles and drains a watershed area of 6,235 mi^2, entirely within North Carolina (Smock et al. 2005). At its mouth, the average discharge is 3.4 billion gallons each day (Cross et al. 2006). Land use in the Neuse River watershed is 35 percent agriculture, 34 percent forested, 20 percent wetlands, 5 percent urban, and 6 percent other, with a basin wide population density of approximately 186 people per square mile (Smock et al. 2005). The estuary is very shallow (average depth about 3.5 m; maximum depth about 7 m) and receives substantial nutrient loading from a number of sources, including agricultural runoff, industrial discharge, and wastewater from municipal treatment plants (Paerl and Pinckney 1996). High primary production and subsequent increased flux of organic carbon to bottom waters increases oxygen demand. This high oxygen demand in the bottom water combined with a stratified water column that characterize the shallow water Neuse River estuary creates hypoxic conditions that result in fish kill events (Eby and Crowder 2002). The estuary alone has historically accounted for the large majority of fish kill mortalities reported throughout the State of North Carolina, including massive fish kills in excess of 10 million fish in 2009 and 2013 (NCDENR 2013). Degraded water quality resulting from hog farms, urban development, wastewater discharges, contaminants (mercury and PCBs), and other sources is considered a moderately high stressor on the shortnose sturgeon population in the Neuse River (SSSRT 2010). The SSSRT also identified dams (moderately high threat) and bycatch in commercial fisheries (moderate threat) as threats to sturgeon in the Neuse River.

5.2.6.2 Major Southeast Coastal Plains Basins

Several major river basins flow through the Southeast Coastal Plains directly into the Atlantic Ocean including the Cape Fear (Figure 21), Yadkin (or Pee-Dee) (Figure 22), Altamaha (Figure 23), and St. Johns river (Figure 24) basins. Rainfall is abundant in the region and temperatures are generally warm throughout the year. While some of these rivers originate at high elevations (i.e., Blue Ridge Mountains or Piedmont Plateau), they all have sizeable reaches of slack water as they flow through the flat Coastal Plain. In the Coastal Plain reaches the acidic characteristics, slow flowing water, poor flushing and high organic and mineral inputs gives these waters their characteristic “blackwater” appearance.

Land use across this region is dominated by agriculture and industry, and to a lesser extent timber and paper production. Population density is highly variable by watershed within the region. The greatest density is in the St. Johns River watershed (~ 200 people per square mile) which includes Jacksonville, Florida. By comparison, there are only 29 people per square mile in the Satilla River watershed in Georgia (Smock et al. 2005).

Figure 21. Map of Cape Fear basin (Source: NOAA).

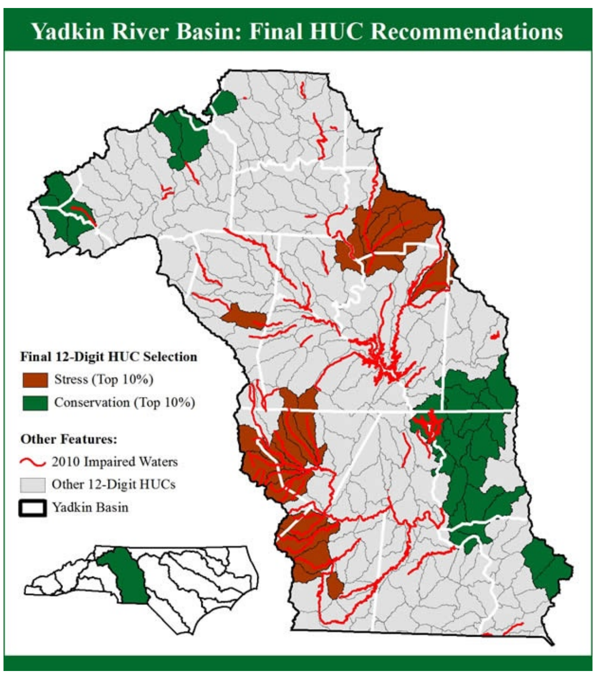

Figure 22. Yadkin River basin map (Source: Piedmont Triad Regional Council).

Several water bodies within this region exhibit high nitrogen loads including the Cape Fear River, Winyah Bay, Charleston Harbor, St. Helena Sound, Savannah River, Ossabaw Sound, Altamaha River, and St. Mary's River and Cumberland Sound (Bricker et al. 2008). Elevated levels of metals including mercury, fecal coliform, bacteria, ammonia, turbidity, and low DO are also a problem in many of the Southeast Coastal Plains Rivers. These impairments are caused by a combination of municipal sewage overflows, mining, non-point source pollution, waterfowl, urban runoff, marinas, agriculture, and industries including textile manufacturing, power plant operations, paper mills and chemical plants (Berndt et al. 1998; Smock et al. 2005).

Water quality is a moderately high source of stress on the Cape Fear and Savannah River shortnose sturgeon populations due to nutrient loading, periodic algal blooms in some tributaries, very low DO concentration levels, and a shift in the salt wedge upriver (SSSRT 2010). Water quality is also considered a moderate stressor on the following shortnose sturgeon populations: Winyah Bay Complex due to mercury, PCBs, dioxin, water withdrawal, and paper mills; Ogeechee, Satilla, and St. Mary's rivers due to low DO concentrations and low groundwater levels that degrade summer habitat; and the St. John's River due to industrial and non-point sources discharges, nutrient loading, elevated water temperatures, and low DO ((SSSRT 2010). Populations of Atlantic sturgeon are also likely impacted by degraded water quality in these systems.

Several of the Southeast Coastal Plains Rivers have been modified by dams and impoundments. There are three locks and dams along the mainstem Cape Fear River (between rkm 97 and 185) and a large impoundment on one of its tributaries, the Haw River (Smock et al. 2005). The lower Cape Fear and its tributaries are relatively undisturbed. The lower reach is a blackwater river with naturally low DO, which is compounded by the reduced flow and stratification caused by the upstream reservoirs and dams (Smock et al. 2005). The Yadkin (or Pee Dee) River is heavily utilized for hydroelectric power. There are many dams on Santee-Cooper River System. The

Santee River Dam forms Lake Marion and diverts the Santee River to the Cooper River, where another dam, St. Stephen Dam, regulates the outflow of the Santee River. Lake Moultrie is formed by both St. Stephen Dam and Pinopolis Dam, which regulates the flow of the Cooper River to the ocean. Below the fall line, the Savannah River is free-flowing with a meandering course, but above the fall line, there are three large dams that turn the piedmont section of the river into a 100-mile long stretch of reservoir (Smock et al. 2005). Although the Altamaha River is undammed, hydropower dams are located on two of its tributaries (Oconee and Ocmulgee Rivers) above the fall lines. There are no dams along the entire mainstem of the Satilla River. The mainstem St. John's River is also free from dams but one of its largest tributaries has a dam on it, and the river's flow is altered by water diversions for drinking water and agriculture (Smock et al. 2005). The SSSRT ranked dams as a high source of stress and major threat to shortnose sturgeon populations in the Cape Fear River, Santee River, Cooper River, and Lakes Marion and Moultrie in Santee-Cooper Reservoir System (SSSRT 2010). Dams were also considered a moderate stressor on sturgeon in the Winyah Bay Complex and Savannah River, and a moderately high source of stress in the St. Johns River.

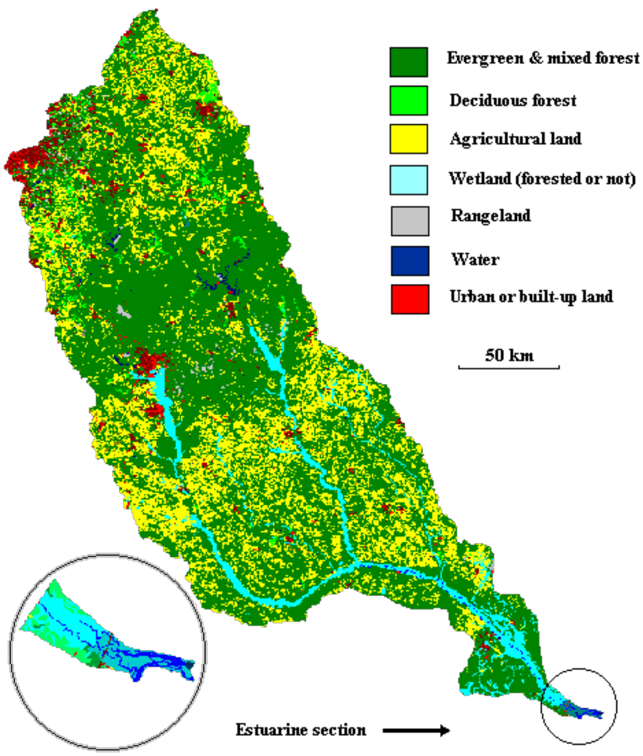

Figure 23. Land use and land cover in the Altamaha River watershed (Source: Georgia Rivers LMER).

Commercial gill net fisheries for shad that operate in Southeast Coastal Plains Rivers and estuaries result in sturgeon bycatch. The SSSRT ranked bycatch as a high source of stress on the shortnose population in the Santee River and Lakes Marion and Moultrie, a moderately high source of stress on shortnose populations in the Winyah Bay Complex and Savannah River, and a moderate source of stress in the Altamaha, Ogeechee, and Cape Fear rivers (SSSRT 2010). Dredging of the Savannah River navigation channel in areas of overwintering and foraging is considered a major threat to shortnose sturgeon. Dredging is also considered a threat to shortnose sturgeon populations in the Cape Fear (moderately high stressor) and Winyah Bay Complex (moderate stressor).

Figure 24. St. John's River watershed (Source: St. John's River Watershed Management District).

6 EFFECTS OF THE ACTION

Section 7 regulations define "effects of the action" as the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur. This effects analyses section is organized following the stressor, exposure, response, risk assessment framework.

This biological and conference opinion includes an effects analysis for the following ESA-listed species/DPSs: five Atlantic sturgeon DPSs, shortnose sturgeon, smalltooth sawfish, Atlantic salmon GOM DPS, six sea turtle species/DPSs (green North Atlantic DPS, hawksbill, Kemp's ridley, olive ridley, leatherback, and loggerhead Northwest Atlantic DPS). An adverse modification effects analysis was not conducted for this opinion since we determined that none of the designated (or proposed) critical habitat within the action area was not likely to be affected by the proposed action.

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of an ESA-listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

6.1 Stressors Associated with the Proposed Action

The potential stressors associated with activities proposed under the proposed Program that could pose a risk to Atlantic or shortnose sturgeon are:

1. Interactions between research vessels and sturgeon including effects of vessel noise, presence, and potential vessel/propeller strikes
2. Capture of sturgeon in anchor gill nets, drift gill nets, trammel nets, trawls, trotlines, pound and trap nets, and beach seines
3. Recapture of sturgeon in anchor gill nets, drift gill nets, trammel nets, trawls, trotlines, pound and trap nets, and beach seines
4. Capture of sturgeon early life stages with egg mats and D-nets
5. Anesthetization using chemical anesthesia techniques (tricaine methanesulfonate, MS-222) and electronarcosis (also known as electroanesthesia or galvanonarcosis)
6. Holding and handling sturgeon for procedures and measurements
7. Measuring and weighing sturgeon
8. Transporting sturgeon
9. Ultrasound

10. Tissue sampling from sturgeon soft fin tissue
11. Injection of PIT under sturgeon skin
12. Attachment of external (floy, dart and T-bar) tags at base of dorsal fin
13. Attachment of external telemetry tags and pop-up satellite archival tags to dorsal fin or to scutes
14. Gill biopsy on outer portion of gill or gill filaments
15. Blood collection
16. Insertion of borescope probe through the genital opening and into genital tract
17. Insertion of a laparoscope/laparoscopic biopsy instrument through small incision in sturgeon ventral body wall for laparoscopy/gonad biopsy
18. Removal of small section (~1 cm^2 notch) of sturgeon pectoral-fin ray
19. Removal of portion of sturgeon scute spine
20. Invasive surgical procedure for placement of internal telemetry tag
21. Passing polyethylene tube through sturgeon alimentary canal and flooding stomach cavity with water for gastric lavage

The potential stressors associated with activities proposed under the proposed Program that could pose a risk to ESA-listed non-target species (i.e., sea turtles, Atlantic salmon, and smalltooth sawfish) are:

1. Interactions between research vessels and non-target species including effects of vessel noise, physical presence, and potential vessel/propeller strikes
2. Incidental capture of non-target species in anchor gill nets, drift gill nets, trammel nets, trawls, trotlines, pound and trap nets, and beach seines
3. Incidental recapture of non-target species in anchor gill nets, drift gill nets, trammel nets, trawls, trotlines, pound and trap nets, and beach seines

6.2 Mitigation to Minimize or Avoid Exposure

As a condition of their permit, researchers will be required to follow specific protocols to avoid, minimize, and mitigate the unintended detrimental effects that may result from research activities such as capture, handling, or performing various invasive procedures. Specific permit conditions intended to mitigate adverse effects on both target and non-target ESA-listed species are described for each research activity in Section 2.3 above, with more details provided in Appendix C. In addition to these standard protocols, as a condition of their permit researchers are required to consider additional precautionary measures they can take to further minimize potential impacts of their research on individual sturgeon.

Mitigation to minimize or avoid exposure of ESA-listed species to adverse effects is a core principle of the Permits Division’s mission to “protect and conserve marine mammals and threatened and endangered species by providing special exceptions for take, import, and export that maximize recovery value <u>and minimize individual and cumulative impacts</u> as directed under ESA section 10(a)(1)(A) and its regulations" (NMFS 2017). Specific mitigation related criteria the Permits Division considers when issuing permits include the following: (1) whether alternative non-endangered species or population stocks can and should be used, (2) how the research is not unnecessarily duplicative of other work, (3) how the applicant will coordinate activities with other Permit Holders; and (4) how the applicant will minimize impacts of the activities, in particular mortality.

In addition to the minimization and avoidance measures that are built into the research permitting process or specified as a condition of the permit, the Permits Division has proposed an adaptive management approach that continuously updates and improves on the mitigation measures currently in place. The mitigation measures included in a sturgeon research permit can be modified by the Permits Division at any time based on investigation into a researcher reported incident of take, new information regarding potential impacts of authorized activities, or demonstrated improvements to the standard protocols for sturgeon research.

6.3 Exposure, Response, and Risk Analysis

This section evaluates the (1) exposure of ESA-listed species to adverse effects resulting from the proposed action, (2) the range of responses those species may exhibit, and (3) the consequences of the responses to the individuals that have been exposed, the populations those individuals represent, and the species those populations comprise. This section is divided into the following subsections by species or species group: sturgeon, Atlantic salmon, smalltooth sawfish, and sea turtles.

6.3.1 Sturgeon Exposure and Response Analysis

This section is divided into subsections analyzing Atlantic and shortnose sturgeon exposure and response to research vessel interactions, capture methods, and particular research procedures authorized in research permits. Our sturgeon exposure analysis focuses on those capture methods and research procedures that, based on our response analysis, we determine may result in mortality, serious injury, or reduced fitness of individual sturgeon. The sturgeon risk analysis that follows will then consider responses to all activities conducted as part of the proposed action and evaluate the combined effects of those responses on sturgeon individuals, populations, and species (or DPSs).

The annual number of sturgeon takes requested by researchers, authorized by the Permits Division, and actually conducted is expected to fluctuate somewhat over the course of the proposed Program. Requested takes may vary due to changes in researcher objectives or available funding sources. Authorized takes may vary due to changes in requested take levels, sturgeon population sizes, trends or health, or other factors affecting maximum mortality limit levels. Actual takes may also vary due to changes in authorized take levels, distribution and abundance of sturgeon, and associated catchability of capture gear. Despite the unpredictable nature of sturgeon directed research take numbers, the maximum mortality limits do establish program wide limits on takes that may affect fitness. Thus, while the number of sturgeon exposed in the future to the various research activities may be difficult to accurately predict, the relative fitness consequences of that exposure (i.e., percent mortality) are predictable and established according to the maximum mortality limit process. The 2017 permit applications represent the best current available information regarding the anticipated exposure of Atlantic and shortnose sturgeon to activities authorized as part of the proposed Program. However, we recognize that these numbers are likely to change in the future and so focus our analysis on the expected response of individual sturgeon to various research activities.

The number of individual sturgeon that may be exposed to the stressors associated with the various activities that are part of the proposed action was estimated based on information from current (2017) permit applications. Thirteen of the 17 active section 10(a)(1)(A) scientific research permits that authorize the study of shortnose and Atlantic sturgeon are set to expire in 2017 (Appendix E). The Permits Division received nine new permit applications for research on wild sturgeon in 2017 that will be considered for inclusion within this programmatic. Information from these nine new permit applications was used to estimate the number of authorized sturgeon captures and procedures anticipated annually under the programmatic. Based on reported captures by sturgeon researchers from 2012-2016, only a small percent of the authorized takes (juvenile, subadult, and adult) by capture resulted in actual captures (11.8 percent for Atlantic sturgeon, 9 percent for shortnose). However, we cannot assume that the ratio of actual captures to authorized captures will remain the same over time, particularly since there is no sunset date on the proposed action. Therefore, our estimate of the number of sturgeon that will be exposed to capture in nets under the proposed action is based on the conservative assumption that 100 percent of authorized sturgeon capture takes will result in actual captures.

6.3.1.1 Research Vessel Interactions

Impacts from research vessel interactions are expected to be minimal to individual sturgeon. The presence of the research vessel may disturb sturgeon, resulting in their movement away from the vessel for a short time. Reactions may include a brief startle response, diving, submerging, or attempting to evade the vessel or research personnel. Based on the anticipated responses, any disruptions are expected to be temporary in nature, with sturgeon resuming normal behaviors shortly after the exposure. No reduction in fitness or overall health of individual sturgeon is anticipated due to the presence of research vessels in areas occupied by sturgeon. A research vessel strike could result is serious injury or death of sturgeon. However, the likelihood of this occurring is extremely small (i.e., discountable) given that (1) sturgeon vessel strikes are rare to begin with, (2) research vessels account for a very small fraction of vessel activity in the action area, (3) research vessel operators will likely be more cautious, particularly in areas where sturgeon are known to occur, and (4) there has never been a reported incident of a NMFS permitted research vessel striking an Atlantic or shortnose sturgeon. In the unlikely event that a research vessel strikes an Atlantic or shortnose sturgeon, the researcher will be required to report the incident to the Permits Division. If the vessel strike results in mortality, the maximum mortality limit for that species, river system, and life stage would be adjusted accordingly.

6.3.1.2 Capture in Gillnets, Trammel Nets and Trawl Nets

Entanglement in gillnets, trammel nets, and trawl nets can constrict a sturgeon's gills, resulting in increased stress and risk of suffocation (Collins et al. 2000; Kahn and Mohead 2010; Moser et al. 2000). Sturgeon stress and mortality associated with capture in nets has been directly related to environmental conditions. However, except for very rare instances, results from previous sturgeon research indicate that capture in nets does not cause any effects on the vast majority of fish beyond 24 hours. For all species of sturgeon, research has revealed that stress from capture is affected by temperature, DO, and salinity, and this vulnerability may be increased by the research-related stress of capture, holding, and handling (Kahn and Mohead 2010). Other factors affecting the level of stress or mortality risk from netting include the amount of time the fish is caught in the net, mesh size, net composition, and, in some instances, the researcher's experience level or preparedness. Analysis of the empirical evidence suggests that individuals collected in high water temperatures and low DO concentrations, combined with longer times between net checks, were more at risk to mortality and stress (Kahn and Mohead 2010). As a condition of their permit, researchers will be required to take necessary precautions while deploying capture gear to ensure sturgeon are not unnecessarily harmed, including: (1) continuously monitoring nets, (2) removing animals from nets as soon as capture is recognized, and (3) following the required water temperature, minimum DO level, and net set duration permit conditions (Section 2.3.1 and Appendix C). These actions are expected to substantially reduce the likelihood of injuring or killing sturgeon during research activities.

Since 2006, conservative mitigation measures implemented by NMFS through permit conditions (e.g., reduced soak times at warmer temperatures or lower DO concentrations, minimal holding or handling time) and additional precautions taken by sturgeon researchers have significantly reduced the lethal and sublethal effects of capture in gill, trammel and trawl nets on Atlantic and shortnose sturgeon. Shortnose sturgeon mortality from capture in nets has declined over time due to these mitigation measures. Prior to 2005, permitted sturgeon researchers reported 26 shortnose sturgeon killed by capture gear out of 5,909 captured, for a capture mortality rate of 0.44 percent. From 2006 through 2016, researchers reported only two shortnose sturgeon killed by capture gear out of 7,019 captured, for a capture mortality rate of 0.03 percent. From 2012-2015, the mortality rate associated with Atlantic sturgeon capture in scientific research was 0.22 percent (14 killed out of 6,466 captured). This overall mortality rate is inflated by a single incidence of mortality where nine Atlantic sturgeon subadults were reported killed. These fish were captured within a large aggregation of Atlantic sturgeon in the Long Island Sound, where uncontrollable, sweeping currents caused unforeseen mortality in gill nets in a two-hour net set duration.

Although such incidents are often unforeseen, as part of the adaptive management approach to the proposed Program, further mitigation measures will be added by the Permits Division to permits, where appropriate, to reduce the likelihood of similar incidents in the future.

Based on current permit applications, which are expected to be issued in early 2017, researchers are requesting take for the capture of approximately 12,000 Atlantic sturgeon (juvenile, subadult, and adult combined) annually. We anticipate the large majority of Atlantic sturgeon will be captured by gill nets (~ 96 percent) with only a small percent captured in trawl nets or other sampling gears. Based on the 2017 permit applications, the largest number of Atlantic sturgeon research takes by capture in gill or trawl nets will likely come from the New York Bight DPS (~ 51 percent), followed by the South Atlantic DPS (~ 28 percent), Chesapeake Bay (~ six percent), GOM (~ three percent), and Carolina (~ one percent). The remaining 11 percent will likely be divided among the DPSs as several researchers requested take "range-wide" for research conducted in areas with mixed-stocks of Atlantic sturgeon. We estimate that about 35 percent of the take by capture in gill/trawl nets in 2017 will be adult/subadult sized fish (≥ 1,000 mm FL), with the remaining 65 percent juvenile Atlantic sturgeon. Based on 2017 permit applications, the Permits Division will authorize the following number of "in-hand" Atlantic sturgeon capture mortalities by DPS: GOM 1 adult/subadult and 1 juvenile; New York Bight 6 adult/subadult and 10 juvenile; Chesapeake Bay 2 adult/subadult and 1 juvenile; Carolina 0 adult/subadult and 0 juvenile; and South Atlantic 4 adult/subadult and 6.8 juvenile.

For shortnose sturgeon, based on 2017 permit applications, researchers are requesting take for the capture of approximately 9,000 juveniles, subadults, and adults combined annually. Similar to Atlantic sturgeon, the large majority of shortnose sturgeon will be captured in gill nets (~ 94 percent). We estimate that about 81 percent of the take by capture in gill/trawl nets in 2017 will be adult/subadult shortnose sturgeon (< 450 mm FL), with the remaining 19 percent juvenile sized fish. Any reported "in-hand" shortnose sturgeon mortalities resulting from capture in gill net, trammel nets or trawls will be counted against the maximum mortality limit for that species, river system, and life stage. Based on 2017 permit applications, the Permits Division will authorize "in-hand" capture mortality of 13.8 adult/subadult and 11.8 juvenile shortnose sturgeon.

While the take of sturgeon resulting from capture in nets will not be capped as part of the proposed Program, mortality will be capped based on the maximum mortality limit approach proposed in Section 2.5. Once the maximum mortality limit is reached, additional capture of sturgeon will no longer be authorized for that particular species, river system, and life stage. This is necessary to avoid exceeding the maximum mortality limit, since there is some (albeit a very small) rate of mortality associated with the capture of sturgeon in nets. Thus, the exposure from capture in nets may be less than estimated above which does not factor in the potential reduction in take by capture resulting from reaching an annual mortality limit for a given species/DPS, river system and life stage.

In summary, while the capture of Atlantic and shortnose sturgeon in gill nets, trammel nets, and trawls may result in short-term negative effects (i.e., elevated stress levels, net abrasion), with the exception of those very rare instances of capture mortality, these activities are not expected to result in reduced fitness or have any long-term adverse effects on individual sturgeon. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are closely followed by all permit holders.

6.3.1.3 Capture in pound nets, trap nets, & beach seines

As part of the proposed action, Atlantic and shortnose sturgeon may be captured using pound nets and trap nets where authorized by state regulations or exemptions. The Permits Division may also authorize the holding of unstressed Atlantic sturgeon in specialized, enclosed pound nets (without wings) for up to 24 hours when environmental conditions are favorable. These gear would serve as an expanded “holding pen,” for maintaining sturgeon over a longer period when necessary. Based on 2017 permit applications, there are no researchers currently requesting take for the capture of Atlantic or shortnose sturgeon in pound nets, trap nets, or beach seines. However, since such gears could potentially be authorized by the Permits Division as part of the proposed Program during future permit cycles, we analyze the response to such gears as part of this programmatic.

Since fish will be trapped within pound, beach seines, or other trapping nets, and not gilled or immobilized, sturgeon captured in these gears will be less likely to be injured, stressed, or affected by net abrasion compared to capture in gill nets. If researchers follow the proper sampling protocols and mitigation measures (discussed in Section 2.3 above), the level of stress associated with capture in pound nets and trap nets is anticipated to be low enough to result in no long-term behavioral change or reduced fitness of individual Atlantic or shortnose sturgeon. As an additional mitigation measure, because of the potential for sea turtle interactions, pound and trap nets will only be used when sea turtles are not anticipated to be in the action area (e.g., in cold water < 18°C or in freshwater environments).

Beach seines may be used as part of the proposed action to target early life stages, young of year, and early juvenile sturgeon foraging along flat sandy areas of rivers and estuaries that would not be able to out-swim the hauling action of the seine. This method could potentially expose captured animals to increased turbidity and reduced water quality due to their crowding among debris and other non-targeted fish species as the seine is gathered. However, the stress of this sampling method on sturgeon will be mitigated by the following permit conditions: (1) when drawing a beach seine's lead line close to shore, animals must not be crowded, and clear waters with minimal turbidity or mud bottoms must be maintained when fish are gathered, (2) all animals will be handled and released within 15 minutes after pooled along the shore, (3) bycatch will be minimally handled and released unharmed, (4) areas sampled will not be seined more than once in a 24-hour period, and (5) areas sampled will be characterized by sandy, flat bottoms free of organic matter, debris or bottom snags.

In summary, while the capture of Atlantic and shortnose sturgeon in pound nets, trap nets, and beach seines may result in short-term negative effects (i.e., elevated stress levels), these activities are not expected to result in reduced fitness, long-term adverse effects, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are closely followed by all permit holders.

6.3.1.4 Capture with trotlines

As part of the proposed action, Atlantic and shortnose sturgeon may be captured with trotlines. Based on 2017 permit applications, there are no researchers currently requesting take for the capture of Atlantic or shortnose sturgeon using trotlines. However, since trotlines could potentially be authorized by the Permits Division as part of the proposed Program during future permit cycles, we analyze the response to this gear type as part of this programmatic.

Stress and mortality resulting from capture on trotlines has not been evaluated for shortnose or Atlantic sturgeon. Based on research on surrogate species, the potential for mortality from this gear appears to be low. Elliot and Beamesderfer (1990) reported one direct mortality of white sturgeon out of 826 individuals captured with trotlines. Steffensen et al. (2013) reported one mortality during the capture of 1,366 pallid and shovelnose sturgeon, and noted that they believed this was not a direct effect of hooking. The authors also found a positive relationship between fish stress and the amount of time the individual was hooked, but that all fish retracted their mouths to a normal position within ten minutes.

Based on previous studies with other sturgeon species, there appears to be an extremely small risk (< 0.1 percent) of mortality resulting from the capture of Atlantic and shortnose sturgeon using trotlines. If trotlines are used, the Permits Division will closely monitor mortality rates resulting from capture with this gear type. Any reported "in-hand" mortalities resulting from trotlines will be counted against the maximum mortality limit for that species, river system, and life stage.

In summary, while the capture of Atlantic and shortnose sturgeon using trotlines may result in short-term negative effects (i.e., elevated stress levels, hook wounds), this activity is not expected to result in reduced fitness or long-term adverse effects. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.5 Early life stages sampling gears

Some research permits issued under the proposed action will authorize the use of egg mats, D-nets or epibenthic sleds to collect early life stages (eggs and larvae) of shortnose and Atlantic sturgeon. These gears typically result in the mortality of early life stage individuals collected. As described in Section 2.5.4 (Authorizing Mortality of Early Life Stages), maximum mortality limits will be established for early life stage sampling of Atlantic and shortnose sturgeon. As part of the proposed Program, up to 16,000 Atlantic sturgeon and 1,080 shortnose sturgeon eggs and larvae may be lethally taken by researchers per year from each river system (i.e., spawning stock). Based on the current permit applications, the actual number of sturgeon eggs and larvae mortalities anticipated in 2017 will likely be significantly lower than the maximum mortality limits may allow. Researchers requested 2,470 Atlantic sturgeon and 780 shortnose sturgeon early life stage takes annually across all river systems combined in 2017.

6.3.1.6 Handling and measurements

As part of the proposed action, after capture all sturgeon will be subjected to handling for length and weight measurements. The number of individual juvenile, subadult and adult Atlantic and shortnose sturgeon exposed to the stressors associated with handling and taking measurements would be the same as the number captured (see “Expected responses to capture in gillnets, trammel nets, and trawl nets” above for details). Despite their general hardiness, handling sturgeon after capture can lead to severe stressed or even mortality if done improperly or in combination with unfavorable environmental conditions such as elevated water temperatures or low DO (Kahn and Mohead 2010; Moser et al. 2000). Handling stress generally increases the longer sturgeon are held out of the water. Total handling time and associated stress will be greater for individual sturgeon undergoing invasive procedures. 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 may also inflate their swim bladder when held out of water, and if they are not returned to neutral buoyancy prior to release they will float and possibly be susceptible to sunburn and bird attacks (Kahn and Mohead 2010; Moser et al. 2000). A study by Moser and Ross (1995) suggested that under certain circumstances pre-spawning adults that are captured may interrupt or abandon their spawning migrations after being handled (Moser and Ross 1995). However, based on telemetry data and other observations of individual animals captured on the spawning ground, Kahn et al. (2014) found that adult sturgeon did not stray far from the site of capture and many immediately returned to spawning behavior as soon as they were released.

Although sturgeon can be sensitive to handling stress, handling of fish by researchers will be kept to a minimum. Sturgeon researchers will follow NMFS recommended research protocols developed by Kahn and Mohead (2010) and endorsed by Damon-Randall et al. (2010) in order to minimize potential handling stress and indirect effects resulting from handling. Permit conditions require that once a fish is captured the total handling time for onboard procedures do not exceed

20 minutes. However, for fish that are not anesthetized, handling times will be considerably lower (i.e., under two minutes) and recovery times, though variable, are expected to last for approximately 30 seconds on average. Researchers will be required to maintain captured sturgeon in net pens or in onboard aerated tanks until they are processed, at which time they will be transferred to another processing station onboard the research vessel. Following processing, fish will be returned to the net pen for observation to ensure full recovery (return to equilibrium, reaction to touch stimuli, return of full movement) prior to release.

In summary, while handling can increase stress if done incorrectly, when researchers follow the appropriate protocols the stress of handling does not increase above the initial stress response from capture, and is believed to have no long-term adverse effects on sturgeon.

6.3.1.7 Recapture

As part of the proposed action, individual Atlantic and shortnose sturgeon could potentially be captured more than once during a sampling day. Cumulative physiological stress can result from net abrasion, injury, and handling of sturgeon when fish are captured multiple times within a relatively short period (i.e., a few hours). Recaptured animals that have not properly recovered from stressors associated with the previous capture have a higher risk of mortality. As a mitigation measure to minimize the risks associated with recapture, as a condition of the permit, sturgeon researchers will be required to cease all sampling for the day after an individual Atlantic or shortnose sturgeon is captured three times on the same day. With this mitigation measure in place, permit holders will have incentive to avoid recapturing the same fish on a given day. Although recaptures may still occur, we anticipate they will be limited in number because of this permit condition. For recaptured fish, researchers will still be required to adhere to the sampling protocols and mitigation measures for safe handling of sturgeon (discussed above), including returning fish to the net pen for observation to ensure full recovery (return to equilibrium, reaction to touch stimuli, return of full movement) prior to release. Recaptured fish may need more time to achieve full recovery prior to release.

In summary, while the recapture of sturgeon in a given day may result in increased levels of stress responses, those responses are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.8 Transport

As part of the proposed action, permit holders may be authorized to transport both wild and captive Atlantic and shortnose sturgeon. As a condition of the permit, wild-caught sturgeon that are transported to facilities to meet proposed research objectives must be released alive at the site of capture within 12 hours. Based on 2017 permit applications, there are no researchers currently requesting authorization to transport Atlantic or shortnose sturgeon. However, since the transport of sturgeon could potentially be authorized by the Permits Division, as part of the proposed Program during future permit cycles, we analyze the response to this activity as part of this programmatic.

The Permits Division has specific guidelines and mitigation measures that permit holders must follow when transporting sturgeon to minimize stress and risk of injury or death. These include specifications for the concentration of fish relative to tank size (i.e., cubic footage), transport water quality (i.e. DO, temperature) and quantity, acclimation to new environment, and researcher observation requirements to assure fish are healthy (see Section 2.3.2 and Appendix C for details).

In summary, while transporting sturgeon may cause short-term stress responses, those responses are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the transporting protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.9 Tissue sampling

Immediately prior to each wild captured sturgeon's release, a small sample (1 cm^2) of soft fin tissue will be collected from the trailing margin of the pelvic fin using a pair of sharp scissors. The estimated number of individual juvenile, subadult and adult Atlantic and shortnose sturgeon exposed to fin-clipping would be approximately the same as the number exposed to capture (see “Expected responses to capture in gillnets, trammel nets, and trawl nets” above for details). To limit the chance of infection occurring from the procedure, researchers will be required to follow disinfection protocols described in the permit conditions (e.g., Appendix C). Based on results from previous studies, this procedure does not appear to result in any injury or long-term adverse effect on Atlantic or shortnose sturgeon (Kahn and Mohead 2010). Sturgeon bleed very little, if at all, after the procedure, and researchers report healing occurs within days to a couple of weeks. There is also no indication that the removal of such a small portion of the fin impairs the sturgeon’s ability to swim.

In summary, while tissue sampling may result in short-term negative effects (i.e., elevated stress levels, bleeding), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.10 PIT tagging

PIT tagging is a common research technique for identifying individuals and has been widely used on a variety of fish species (Clugston 1996; Dare 2003; Eyler et al. 2004; Skalski et al.

1998), as well as other taxa (i.e., amphibians, birds, and mammals). PIT tags, which are biologically inert, have not been shown to cause some of the problems associated with other fish tagging methods such as scarring, tissue damage, or adversely effects on growth and survival (Brännäs et al. 1994). Previous studies have demonstrated that when PIT tags are inserted into animals having large body sizes relative to the tag size, this procedure has no adverse effect on the growth, survival, reproductive success, or behavior of individual animals (Brännäs et al. 1994; Clugston 1996; Elbin and Burger 1994; Hockersmith et al. 2003; Jemison et al. 1995; Skalski et al. 1998). The large majority of sturgeon that will be exposed to PIT tagging as part of the proposed action will be relatively large (> 300 mm). Typical tags sizes used for sturgeon are 11.5mm or 14mm. The use of the larger (14 mm) tags will only be authorized by the Permits Division for sturgeon that are at least 450 mm long. A study conducted at Bears Bluff National Fish Hatchery on shortnose sturgeon found 100 percent survival of PIT tagged fish > 300 mm TL using 11.5-mm tags (NOAA Tech Memo NMFS-NE-215).

The Permits Division may authorize some permit holders to PIT tag smaller sturgeon (250 mm to 300 mm) under particular circumstances and conditions. Studies in other fish species show mortality can occur from PIT tagging juvenile fish (age-0/1) (Dare 2003; Gries and Letcher 2002; Muir et al. 2001). However, Hamel et al. (2013) tagged age-1 pallid sturgeon (214 – 358mm FL) using 12mm tags and reported zero mortality after 189 days. To minimize the risk of adverse effects from PIT tagging smaller sturgeon, only PIT tags that are 8.4 mm or smaller will be authorized on Atlantic and shortnose < 300 mm. Empirical studies show that PIT tagging Atlantic and shortnose sturgeon using the required sampling protocols, mitigation measures and tag sizes does not appear to result in any long-term adverse effects or reduced fitness to individual sturgeon (Damon-Randall et al. 2010; Henne and Crumpton 2008; Kahn and Mohead 2010).

All previously untagged Atlantic and shortnose sturgeon captured as part of the proposed action that are at least 300 mm long will be PIT tagged. We anticipate that the number of sturgeon exposed to PIT tagging would be similar to the number exposed to capture (see "Expected responses to capture in gillnets, trammel nets, and trawl nets" above for details), although somewhat smaller to account for capture of sturgeon that were previously PIT tagged and sturgeon < 300 mm that are not PIT tagged. To avoid double-tagging, researchers would be required to scan the entire dorsal surface of each sturgeon captured to detect prior PIT tags.

In summary, while PIT tagging Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., elevated stress levels, bleeding), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.11 External identifier tags

In addition to internal PIT tags, some sturgeon captured as part of the proposed action will be tagged with an external identifier tag (e.g., Floy t-bar, dart, and anchor tags). T-bar and other anchor tags are typically interlocked between inter-neural cartilages in the dorsal fin. This can result in potential bleeding and/or injury from the injecting needle used to insert such tags (Collins et al. 1994). The potential for injury is greatly reduced when tags are applied by experienced biologists and technicians. Injection of T-bar tags into the dorsal musculature may also result in raw sores, enlarging over time with tag movement (Collins et al. 1994; Guy et al. 1996). Minimal research has been conducted on the long-term effects of these types of tags on sturgeon fitness or growth rates. Anecdotal evidence, based on recovery of fish many years after tagging, suggests that delayed mortality associated with T-bar tags is low, although no data are available to evaluate the effects on growth rate (Moser et al. 2000). Studies on the effects of injecting anchor tags on the growth rate of other species show variable results: reduced growth rates have been reported in lemon sharks and northern pike; no effect on growth rates was reported for largemouth bass (Manire and Gruber 1991; Scheirer and Coble 1991; Tranquilli and Childers 1982). To minimize the potential for adverse effects, external identifier tags will not be authorized for sturgeon less than 300 mm TL.

Based on 2017 permit applications, we estimate that about two-thirds of the captured juvenile, subadult and adult Atlantic sturgeon and forty percent of captured shortnose sturgeon will have an external identifier tag attached in 2017. The numbers of fish exposed may be somewhat smaller than these estimates, which do not account for captured fish that already have an anchor tag in place and fish that are less than 300 mm.

In summary, while placing external identifier tags on Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., elevated stress levels, bleeding, sores), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.12 Juvenile Sturgeon Acoustic Telemetry Tagging

As part of the proposed action, the Permits Division may authorize the injection of internal acoustic juvenile sturgeon acoustic telemetry (JSAT) tags (~ 1.5 cm long) into Atlantic or shortnose sturgeon greater than 300 mm. Based on 2017 permit applications, we are not aware of any researchers currently requesting authorization for JSAT tagging. However, since this procedure could potentially be authorized by PR1 as part of the proposed Program during future permit cycles, we analyze the response to this gear type as part of this programmatic.

This method of internal tagging, which does not require surgery or anesthesia, is considered less invasive compared to traditional internal tagging methods. Tests on salmon indicate that the adverse effects of this procedure are likely minimal (Deng et al. 2015). We anticipate this less invasive method will enable sturgeon to heal faster, reduce the risk of infection, lower the risk of mortality, and possibly provide more reliable information about fish behavior.

In summary, while JSAT tagging Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., elevated stress levels, injection needle wound), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.13 External transmitters

Studies on a variety of fish species suggest that attachment of external transmitter tags can result in sub-lethal effects including delayed growth and reduced swimming performance (Anras et al. 2003; Ísaksson and Bergman 1978; Ross and McCormick 1981; Strand et al. 2002; Sutton and Benson 2003). The ratio of tag size to fish size was found to be a predictor of the level adverse effects produced by external transmitters (i.e., larger tags resulted in more negative effects) (Anras et al. 2003; Sutton and Benson 2003). The size, weight of external tags have been greatly reduced over time with technological advancements. To minimize the risks associated with external tagging, particularly on smaller sturgeon, the Permits Division will not authorize the use of external tags weighing more than two percent of the fish’s body weight. Other mitigation measures for use of external transmitter tags include applying only to sturgeon that are in excellent condition after capture and not applying to pre-spawning fish, or in water temperatures greater than 27°C or less than 7°C. Placement of tags will result in needle wounds from threading through the dorsal fin, but these are expected to heal normally with no lasting effects on individual sturgeon.

In summary, while placement of external transmitter tags on Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., elevated stress levels, wounds), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

Based on 2017 permit applications, researchers would be authorized to use external transmitter tags on 635 adult/subadult and 225 juvenile Atlantic sturgeon.

6.3.1.14 External PSAT tags

External PSAT tags have been used by sturgeon researchers to track movement and behavior. However, due to the high cost of tags, this tagging method is used infrequently compared to other sturgeon tracking methods that are less expensive and have proven to be effective in environmental conditions where most sturgeon research occurs. While we are not aware of any current research requests to use PSAT tags on Atlantic or shortnose sturgeon, we will analyze the response to this activity as part of this programmatic since such tags could potentially be authorized by the Permits Division as part of the proposed Program during future permit cycles. Erickson and Hightower (2007) tagged seven green sturgeon with PSATs and reported zero mortality and no signs of adverse effects based on movement data collected on individual fish over a 2-8 month period. The authors also reported no adverse health impacts on a PSAT tagged green sturgeon held in captivity for nearly nine months. PSATs have also been also used to examine the oceanic movements of Atlantic sturgeon (Erickson et al. 2011). Twenty-three adults were tagged and released with PSATs; data from eight of the tags were not transmitted, however, likely due to tag malfunction. All other tagged Atlantic sturgeon were relocated and the PSATs successfully transmitted data. As with other transmitter tags, if PSATs are used by sturgeon researchers the results of tag retention and fish health will be reported to the Permits Division in annual reports, or otherwise as requested by the Permits Division.

In summary, while placement of external PSAT tags on Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., elevated stress levels, wounds, pain), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

Based on 2017 permit applications, researchers would be authorization to use PSAT tags on 335 adult/subadult and 285 juvenile Atlantic sturgeon.

6.3.1.15 Hydro-acoustic testing

Hydro-acoustic testing using side scan and/or DIDSON sonar gear may be conducted by researchers as part of the proposed action to locate sturgeon prior to setting nets for capture. This is considered a non-invasive method that will result in no detrimental effects on sturgeon or other ESA-listed species within the action area. Studies show that, with few exceptions, most fish species cannot hear sounds above about 3 to 4 kHz (Popper and Schilt 2008). In the proposed action, sturgeon researchers will make use of broadband sonar systems operating at 110 to 220 kHz. Therefore, Atlantic sturgeon and shortnose sturgeon are not expected to respond to hydro-acoustic testing. This activity will not likely result in any long-term adverse effects, reduced fitness, or mortality. We did not conduct an exposure analysis for hydro-acoustic testing since sturgeon are not expected to respond to this activity.

6.3.1.16 Anesthesia

The use of an anesthetic reduces the potential for short term stress response and risk of mortality during invasive procedures (Kahn and Mohead 2010). However, the use of some anesthetics have also proven to be stressors to fish as evidenced by the buildup of the cortisol hormone (Iwama et al. 1989). Documented lethal or sub-lethal effects caused by improper dosage or exposure of anesthetics (Iwama et al. 1989; Summerfelt et al. 1990) raises concerns whether it is acceptable to use anesthetic when handling ESA-listed sturgeon (Kahn and Mohead 2010).

MS-222 is absorbed rapidly through the gills and it prevents the generation and conduction of nerve impulses, with direct actions on the central nervous system and cardiovascular system (Kahn and Mohead 2010). When immersed in MS-222, sturgeon will initially experience rapid gill movement followed by marked reduced gill movement as the agent begins to have an effect. As gill movement slows, sturgeon will lose equilibrium and eventually turn upside down or float to the surface. 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). While there are potential risks associated with anesthesia using MS-222, long-term effects can generally be avoided by following the recommended protocols and use concentrations (Kahn and Mohead 2010; Moser et al. 2000). For example, a study on steelhead and white sturgeon revealed deleterious effects to gametes at MS-222 concentrations of 2,250 to 22,500 mg/L, while no such effects occurred at 250 mg/L and below (Holcomb et al. 2004). Haley (1998), Moser et al. (2000), and Collins et al. (2006b) all reported successful anesthetization of shortnose sturgeon with no lingering adverse effects using MS-222 at the recommended concentration levels (up to 150 mg/L). MS-222 concentrations used by authorized researchers under this program are 50 mg/L for gastric lavage and up to 150 mg/l for transmitter implantation. Based on previous research results, exposure of Atlantic and shortnose sturgeon to these MS-222 concentration levels will result in only minimal short-term risk with quick recovery time. Only experienced researchers will be authorized to perform anesthesia to further reduce the risk of overdosage or overexposure. In addition, this procedure will only be performed on animals that are in excellent condition.

Electronarcosis is an alternative anesthetic method using prescribed electrical currents. Alternating current (AC), constant direct current (CDC), and pulsed direct current (PDC) have all been tested on fish. Most studies using AC and PDC reported adverse effects including some bruising, burning, hemorrhaging, and mortality (Holliman and Reynolds 2002; Redman et al. 1998; Tipping and Gilhuly 1996). Consequently, NMFS does not recommend using AC or PDC currents for inducing anesthesia in Atlantic or shortnose sturgeon. Due to the varying results that can occur from electrical current, it is important to use an ideal electrical anesthetic, inducing anesthesia rapidly with minimum hyperactivity or stress (Coyle et al. 2004). When using CDC, the risks to sturgeon are over-applying the direct current resulting in either tetany, cessation of opercular movement, or involuntary respiration (Kahn and Mohead 2010). These adverse effects can be mitigated through proper training, closely monitoring sturgeon, and reducing the voltage, as necessary, in response to changes in fish behavior. Henyey et al. (2002) described using low voltage CDC to induce electronarcosis (muscle relaxation) in shortnose sturgeon without any changes in swimming or feeding behavior, burns, bruising, or mortality after monitoring the fish for six weeks. This electronarcosis technique has since been used widely on Atlantic and shortnose sturgeon. Recovery time from electronarcosis is shorter than for chemical anesthesia, as fish can swim upright as soon as the electricity is turned off (Henyey et al. 2002; Holliman and Reynolds 2002; Summerfelt et al. 1990).

Atlantic and shortnose sturgeon will only be anesthetized prior to particular research procedures for which it has been determined that the risks of performing the procedure without anesthesia outweigh the risks associated using anesthesia. Research procedures authorized as part of the proposed action that are conducted under anesthesia include fin-ray sampling, internal tagging, gonad biopsy, gastric lavage, borescopy, and laparoscopy. Therefore, sturgeon exposure to anesthesia is reflected in our exposure analysis for these procedures.

In summary, while the use of anesthetics (MS-222 and electronarcosis) on Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., increased stress levels, temporary loss of equilibrium), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all sampling protocols (particularly concentrations or electric current levels, and exposure durations), mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders. While mortality from anesthetization is considered unlikely if the proper protocols are followed, we do recognize that there is some risk of mortality associated with these procedures. Any reported “in-hand” mortality that occurs either during application of the anesthetic or subsequently during the recovery period will be counted against the maximum mortality limit for that particular species, river system, and life stage.

6.3.1.17 Gill biopsy

Gill biopsies are generally conducted on fish to determine the presence or absence of external parasites. While we are not aware of any current research requests to conduct gill biopsies on Atlantic or shortnose sturgeon, we will analyze the potential response to this activity as part of this programmatic, since this procedure could potentially be authorized by the Permits Division as part of the proposed Program during future permit cycles. Fast et al. (2009) conducted gill biopsies on 83 Atlantic sturgeon caught in the New York Bight from 2007-2008 and reported no adverse effects resulting from this procedure. As a mitigation measure to minimize bleeding, researchers will only biopsy the outer portion of the gill, not the inner portion where blood flow would be greatest. Thus, while conducting gill biopsies on Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., increased stress levels, minor bleeding and bruising), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

6.3.1.18 Gonad biopsy

Surgical biopsy and histological examination of a sturgeon's gonadal tissue is the most accurate while also the most invasive way to identify the sex and stage of maturity of a sturgeon (Van Eenennaam and Doroshov 1998). There is little information regarding the loss of reproductive potential due to the removal of small samples of gonadal tissue. While it is known that the gonads deliver hormones to the fish that influences behavior (Hernandez-Divers et al. 2004), there have been no studies dealing with potential changes in behavior from small losses of gonadal tissue. There is also sparse information available on the extent of infection or delayed mortality associated with this procedure (Kahn and Mohead 2010). Chapman and Park (2005) monitored Gulf sturgeon for 30 days following biopsy and reported no mortalities.

Due to the increased risk of this procedure, as a mitigation measure gonad biopsies will only be performed in a laboratory setting, except if the researcher is also implanting an internal acoustic tag, in which case the gonad biopsy can be performed in the field (Kahn and Mohead 2010). If researchers follow the proper protocols and mitigation measures as a condition of their permit, this procedure should not result in any long-term adverse effects or a reduction in the fitness of individual sturgeon. We do recognize that there is a slight risk of delayed mortality from this invasive procedure. Based on information in current (2017) permit applications, we anticipate that the large majority of gonad biopsies will be performed in the field in conjunction with placement of an internal acoustic tag, which also has an associated risk of delayed mortality. Thus, anticipated exposure of sturgeon to gonad biopsy will be similar to exposure to internal tagging described below. As described in the proposed action (Section 2.5.2), a delayed mortality rate will be applied to internal tagging procedures conducted on sturgeon to account for this potential source of mortality within the maximum mortality limit. Since these procedures are often performed together, we assume that the delayed mortality rate for internal tagging already accounts for the risk of mortality due to gonad biopsy. For gonad biopsies performed in the lab, researchers will be able to ensure that the fish is fully recovered prior to releasing into the wild. As such, any mortalities that occur from gonad biopsies in the lab will be "in-hand" mortalities prior to release. Any reported "in-hand" mortality would be counted against the maximum mortality limit for that particular species, river system, and life stage.

6.3.1.19 Blood sampling

Effects of drawing blood samples with syringes from the caudal vein of Atlantic and shortnose sturgeon could potentially include pain, handling discomfort, possible hemorrhage at the site or risk of infection. To mitigate these effects, the needle will 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 will be applied to the site of venipuncture to ensure clotting and prevent subsequent blood hemorrhaging (Stoskopf 1993). The site will then be disinfected and checked again after recovery prior to release. Thus, while sampling blood from Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., increased stress levels, pain, and blood loss), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

Based on 2017 permit applications, researchers would be authorized to sample blood from 2,809 adult/subadult and 1,960 juvenile Atlantic sturgeon. Based on 2017 permit applications, researchers would be authorized to sample blood from 4,165 adult/subadult and 397 juvenile shortnose sturgeon.

6.3.1.20 Laparoscopic surgery

Laparoscopy will be used by sturgeon researchers as part of the proposed action to assist in identifying the sex and egg maturity of individual sturgeon. Compared most traditional surgical procedures, laparoscopy is considered a minimally invasive form of surgery that typically involves relatively minor tissue trauma, shorter postoperative recovery periods, decreased postoperative care, and fewer postoperative complications (Kahn and Mohead 2010). Hernandez-Divers et al. (2004) performed lengthy laparoscopic surgeries (45 minutes to an hour) on 17 Gulf sturgeon in a laboratory setting. They reported 100 percent survival and no significant hemorrhaging, trauma, or postoperative swimming or buoyancy problems associated with any of the fish after surgery. Other studies involving laparoscopy of pallid and shovelnose sturgeon has also reported no adverse effects (Wildhaber et al. 2006; Wildhaber and Bryan 2006).

Based on information in past annual reports submitted by sturgeon researchers to NMFS, laparoscopy is a safe procedure that can be routinely performed without complications when carried out by experienced researchers following recommended protocols. The small incision and insertion of the laparoscope typically heals rapidly with no long-term sub-lethal effects on individual fish.

In summary, while conducting laparoscopy on Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., increased stress levels, puncture wound), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

Based on 2017 permit applications, researchers would be authorized to perform laparoscopy on 620 adult/subadult and 258 juvenile Atlantic sturgeon. Based on 2017 permit applications, researchers would be authorized to perform laparoscopy on 33 adult/subadult and 203 juvenile shortnose sturgeon.

6.3.1.21 Borescopy

The greatest potential for injury with this procedure is from passing the fiber optic internally at the juncture of the oviduct and urogenital canal (Kynard and Kieffer 2002). The borescope must be maneuvered carefully beyond the oviduct to clearly view and stage eggs to avoid rupturing the oviduct with the borescope probe tip. Kynard and Kieffer (2002) recommend a gentle, repeated probing of the oviduct valve using preferred 4-mm and smaller diameter probes to avoid penetrating the oviduct valve or damaging the urogenital canal. They concluded that careful use of a properly sized borescope would not harm reproductive structures and would be suitable for most sturgeon species. Wildhaber and Bryan (2006) and Wildhaber et al. (2006) did not document any injuries or mortalities associated with their borescope activities on pallid and shovelnose sturgeon. Borescopy will only be authorized by the Permits Division as part of the proposed action to those researchers having properly documented experience to perform this procedure.

In summary, while conducting borescopy on Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., increased stress levels, discomfort), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

Based on 2017 permit applications, researchers would be authorized to perform borescopy on 770 adult/subadult Atlantic sturgeon. Based on 2017 permit applications, researchers would be authorized to perform borescopy on 1,160 adult/subadult shortnose sturgeon.

6.3.1.22 Sampling fin-ray spines

As part of the proposed action, some researchers may be authorized to remove a small segment (~ 1 cm^2) of the first or second fin-ray spine used to age sturgeon. While this procedure may cause short-term discomfort, bleeding, and minor temporary loss of swimming hydrodynamics in some fish, it is not expected to have a significant impact on the survivability or normal behavior of individuals. To minimize the adverse effects noted, the samples will be collected by individuals trained in this procedure using sterilized surgical instruments while fish are under anesthesia.

Baremore and Rosati (2014) compared the use of otoliths, first fin-ray spines, and secondary fin-rays in aging Gulf sturgeon and determined that sectioning the second marginal fin ray was not only the least harmful to fish, but it was also the most accurate in terms of aging validation. Ruddle (2016) followed this study by sectioning the second marginal fin ray on Atlantic and shortnose sturgeon. Both researchers found that although sampling the second fin-ray was likely to cause discomfort, this technique was less invasive, faster (1-minute), easier to perform in the field, and did not require anesthesia to make the excision. Slight bleeding at the site was common when “snipping” the tissue, but hemorrhaging was generally minimal and ceased within five minutes of the procedure. Additionally, recaptured individuals were healed completely six months after fin-ray sectioning, and the fin showed little or no irritation or redness at the removal site.

In summary, while fin-ray sampling (first or second fin) Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., increased stress levels, discomfort, bleeding), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

Based on 2017 permit applications, researchers would be authorized to sample fin-ray spines from 3,548 adult/subadult and 2,767 juvenile Atlantic sturgeon. Based on 2017 permit applications, researchers would be authorized to sample fin-ray spines from 2,715 adult/subadult and 1,045 juvenile shortnose sturgeon.

6.3.1.23 Scute/hook sampling

Sampling of sturgeon scute spines is a relatively new technique for age determination and chemical reconstruction of natal life histories that may be authorized by the Permits Division as part of the proposed action (Altenritter et al. 2015). The scute tissue itself is a calcified hard structure with relatively little vascularization. The technique of sawing a wedge shaped sample from the scute may result in minor bleeding if the saw penetrates through the scute to underlying tissue at the deepest part of the cut (right under the spinous process). The size of any such wound is likely to be small (a few mm across) and shallow. This minimally invasive technique is considered far less injurious than taking a full scute or fin spine, and is more akin to the amount of tissue trauma associated with fin-clipping or PIT-tagging (Altenritter et al. 2015).

In summary, while scute/hook sampling Atlantic and shortnose sturgeon may result in short-term negative effects (i.e., increased stress levels, minor bleeding), responses to this activity are not likely to manifest into any long-term adverse effects, reduced fitness, or mortality. This conclusion can be reached as long as all of the sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders.

Based on 2017 permit applications, researchers would be authorized to sample scute/apical hook spines from 128 adult/subadult and 42 juvenile Atlantic sturgeon. Based on 2017 permit applications, researchers would be authorized to sample fin-ray spines from 220 adult/subadult shortnose sturgeon.

6.3.1.24 Internal acoustic telemetry tags

Adverse effects associated with the placement of internal telemetry tags in fish include handling discomfort, hemorrhage at the site of incision, risk of infection from surgery, affected swimming ability, reduced growth rates, abandonment of spawning runs, and some incidence of delayed mortality (Adams et al. 1998; Welch et al. 2007; Wildgoose 2000). Since implanting internal telemetry tags is stressful to sturgeon, this procedure also requires the use of anesthesia (see above for discussion of responses to anesthesia). Factors that can affect proper healing of surgical wounds resulting from this invasive procedure include secondary infection and inflammation (Wildgoose 2000). Thorstad et al. (2000) reported that incisions were not fully healed in 13 farmed Atlantic salmon between following (from 6-20 days) transmitter implantation; two of which showed signs of inflammation. Cooke et al. (2003) reported juvenile largemouth bass implanted with micro-radio transmitters exhibited short-term (five days) inflammation around the incision and suture insertion points but in the longer term (20 days) almost all sutures were shed and the incisions were completely healed. Chapman and Park (2005) examined suture healing following a gonad biopsy of Gulf sturgeon and reported all incisions healed 30 days after the intervention. Expulsion or rejection of surgically implanted transmitters in fish can occur as transmitters can be expelled through the incision, through an intact part of the body wall, through the intestine, or with eggs deposition during spawning (J. Kahn, NMFS OPR, pers.comm. to R. Salz, NMFS OPR, December 22, 2016). Although expulsion has been reported in a number of studies, this occurrence does not appear to result in further complications or subsequent mortality (Chisholm and Hubert 1985; Jepsen et al. 2002; Kieffer and Kynard 1993; Lacroix et al. 2004; Moore et al. 1990; Moser and Ross 1995). The risk of tag rejection or expulsion is less likely to occur now that all internal telemetry tags come from the manufacture coated in a biologically inert substance (Kynard et al. 1997; Moser and Ross 1995).

Factors that can affect the success of telemetry transmitter implantation in fish include choice of surgical procedure or technique, fish size, tag size/weight, fish condition, and environmental conditions (Bunnell and Isely 1999; Jepsen et al. 2002; Kahn and Mohead 2010; Moser et al. 2000). The proposed Program includes mitigation measures to reduce the risk of adverse effects resulting from this highly invasive procedure. To minimize the risk of adverse effects on sturgeon internal tagging will not be conducted when the water temperature exceeds 27°C (to reduce handling stress) or is less than 7°C since incisions do not heal as rapidly in low temperatures (Kieffer and Kynard 2012; Moser et al. 2000; Ream et al. 2003). Internal tagging will only be authorized on sturgeon > 300 mm TL and on fish that are in excellent condition (i.e., active, healthy weight). In addition, the weight of the internal telemetry tag selected for implanting must be less than two percent of the fish’s total weight (in air). If sturgeon researchers follow the protocols and mitigation measures required as a condition of their permits, we anticipate the sub-lethal effects associated with internal tagging will be greatly reduced, and primarily limited to short-term effects with no lasting impact on sturgeon fitness or survival.

However, sub-lethal effects could be greater than expected if researchers do not adhere to proper sampling protocols. For example, seven Atlantic sturgeon adults captured from the York River (Chesapeake Bay DPS) were improperly sutured when surgically implanting them with internal sonic devices. Although these fish were later recaptured and re-sutured correctly, and survived, they were considered “harmed” by the research activity (J. Kahn, NMFS OPR, pers.comm. to R. Salz, NMFS OPR, December 22, 2016).

Available information to evaluate delayed mortality associated with implanting internal tags in Atlantic and shortnose sturgeon are limited. Estimating delayed mortality due to tagging from reported sturgeon telemetry tracking results can be difficult since there may be multiple reasons a tag cannot be located (e.g., fish moved out of range, tag expulsion, tag malfunction, natural mortality, or other source of mortality). Collins et al. (2002) recorded no mortality of cultured shortnose sturgeon using internal tags during a three-month study on tagging methods. Necropsies indicated there were no effects on internal organs. NMFS conservatively assessed possible post-release mortality by assuming tags not detected beyond 90 days after tagging represent fish that died as a result of tagging (J. Kahn, NMFS OPR unpublished data collected from 2013-2016; D. Fox, Delaware State University, unpublished data collected 2009-2013). These studies found adult sturgeon mortality rates due to internal tagging ranged from 1.7 percent to 3.0 percent. These are likely conservatively high estimates of post-release mortality from internal tagging due to the assumptions discussed above.

Considering the mitigation measures and permit conditions in place to minimize adverse effects, we anticipate similarly low rates of mortality associated with internal tagging as part of the proposed Program. As discussed above, implantation of internal transmitter tags in Atlantic and shortnose sturgeon may also result in sub-lethal effects including increased stress levels, bleeding, risk of inflammation or infection, tag expulsion, and potential reduction in growth rate or swimming ability. However, given the sampling protocols, mitigation measures, and other required conditions of the sturgeon research permit, we expect these sub-lethal effects will be minimal, short-term, and are not likely to result in any long-term reduced fitness of individual sturgeon.

Invasive research procedures, such as internal tagging, that have some risk of delayed mortality will be authorized conservatively by the Permits Division as part of the proposed Program. See Section 6.3.1.26 below for an analysis of the anticipated exposure to delayed mortality from internal tagging as part of the proposed action. Researchers must demonstrate how the study will benefit recovery of the species and why other, less invasive, procedures could not be used as a substitute for internal tagging. The number of internal tagging procedures that could be authorized would be a function of the available maximum mortality limit level for each particular sturgeon species, spawning stock and life stage and the applied delayed mortality rate (2.5 percent for adults and five percent for juveniles). Permit holders will be required to report the results of internal tagging studies including tag retention, fish health, and survival rates to NMFS in their annual reports. This information will be used to continually update and improve on the estimated delayed mortality rate that will be applied to internal tagging procedures.

6.3.1.25 Expected responses to gastric lavage

Due to the difficulty in navigating the lavage tube past the U-shaped bend of the alimentary canal in sturgeon and the position of its swim bladder, care must be taken to avoid injuring sturgeon when performing gastric lavage. Additionally, potential negative growth responses of sturgeon (going off-feed) after gastric lavage could result from the procedure. Haley (1998) modified previous gastric lavage techniques and developed a lavage protocol using anesthesia and flexible tubing that was safe and effective for use on sturgeon (Kahn and Mohead 2010; Moser et al. 2000). Savoy and Benway (2004) reported results from 246 shortnose sturgeon collected on the Connecticut River between 2000 and 2003. All of the fish tolerated the gastric lavage procedure well and recovered without apparent stress. Brosse et al. (2002) and Wanner (2006) practiced gastric lavage on captive sturgeon with no delayed mortality, prior to conducting lavage in the field. Collins et al. (2008) sacrificed three Atlantic sturgeon to monitor the potential effects of lavage on wild fish; no adverse effects were found in this study. Brosse et al. (2002) reported lavaged sturgeon were in poorer condition than control fish after 60 days due to weight loss. However, Collins et al. (2008) recaptured lavaged fish (over 70 days apart) and documented normal weight gains in the intervals between capture and re-lavage. Other researchers have reported successful gastric lavage work in the field with no immediate mortalities (Brosse et al. 2002; Collins et al. 2008; Guilbard et al. 2007; Haley 1998; Savoy and Benway 2004), although delayed mortality rate remains unknown.

While use of appropriate lavage techniques developed for sturgeon will minimize adverse effects including mortality, there is still a potential risk to individual sturgeon from this procedure that can result from anesthesia, improper lavage technique, or individual sturgeon reacting negatively to the procedure. The negative impacts of gastric lavage on sturgeon remain somewhat uncertain. While it is possible that individual sturgeon undergoing gastric lavage could experience some delayed injury or mortality, we believe the large majority exposed to this procedure will only experience minimal short-term risks such as handling discomfort and possible weight loss. There is no available information on delayed mortality rates associated with performing gastric lavage on Atlantic or shortnose sturgeon. We anticipate that gastric lavage could result in similar complications post-procedure as those associated with internal tagging (e.g., an internal wound or perforation is possible, or effects of anesthesia). For purposes of estimating the number of delayed sturgeon mortalities due to gastric lavage, and until more information become available, the Permits Division proposes applying the same mortality rates for lavage procedures on sturgeon as those applied to internal tagging (i.e., 2.5 percent for adults/subadults; five percent for juveniles). As with other procedures, our estimates of exposure to gastric lavage are subject to change over time with changes in sturgeon population abundance, research objectives or study areas, new techniques, or with updated maximum mortality limits based on new information. See

Section 6.3.1.26 below for an analysis of the anticipated exposure to delayed mortality from gastric lavage as part of the proposed action.

6.3.1.26 Anticipated Exposure to Delayed Mortality from Invasive Procedures

The average annual number of delayed mortalities anticipated from the proposed action can be estimated based on the expected number of internal tagging and gastric lavage procedures that will be authorized in 2017 based on current research permit applications. We use the current permit applications as the best information available to estimate future exposure but fully acknowledge that levels of sturgeon research effort can change over time due to multiple reasons. As part of the proposed action, conservative delayed mortality rates of 2.5 percent and five percent are applied for these procedures on adult/subadult and juvenile sturgeon, respectively. We estimated anticipated delayed mortalities resulting from the proposed action based on the assumption that 100 percent of the authorized procedures will actually be performed. This is a conservative assumption since based on prior year's permits the ratio of actual procedures to authorized procedures was only around 10 to 15 percent.

A comparison of anticipated annual average sturgeon mortalities from based on authorized invasive procedures and capture (i.e., "in-hand") mortalities in 2017 with maximum mortality limits by spawning stock is shown in Tables 17-20 (separate tables for the adult/subadult and juvenile mortality limits for each species). Compared to the 2017 annual maximum mortality limits, our estimates of delayed mortalities plus authorized capture mortalities for 2017 are consistently lower, and for several river systems only a small proportion of the maximum mortality limit will be authorized in 2017. For example, based on 2017 authorized procedures and capture mortalities permit holders can lethally take up to 1.41 adult/subadult Atlantic sturgeon in the Altamaha compared to the maximum mortality limit of 10.6 fish for this river system (Table 17). Even larger discrepancies between authorized 2017 mortalities and maximum mortality limits are found for shortnose sturgeon. For example, based on 2017 authorized procedures and capture mortalities permit holders can lethally take up to 9.13 adult/subadult shortnose sturgeon in the Hudson River compared to the maximum mortality limit of 366 fish for this river system (Table 19). Although we have no information to indicate that future Atlantic and shortnose sturgeon research effort levels will differ appreciably from either past sturgeon research levels or present (2017) sturgeon research requests, it is possible that research levels, and associated exposures, will increase in the future under the proposed Program. However, even if research levels were to increase substantially (e.g., 50 to 100 percent increase), based on the differences shown in Tables 17-20 we would still expect that for many river systems the number of mortalities authorized (delayed plus "in-hand") would still be well below the maximum mortality limits. We do anticipate that these upper mortality limits would be attained for some river systems and in some years, particularly for smaller sturgeon populations or "unknown" systems with very low mortality limits. However, after considering past and present research levels, and factoring in the potential increase in research levels in the future, we anticipate that

Table 17. Comparison of adult/subadult Atlantic sturgeon estimated delayed mortalities based on 2017 authorized invasive procedures plus authorized "in-hand" mortalities with 2017 maximum mortality limits by spawning stock.

DPS (name)	Spawning Stock	Internal Tagging and Gastric Lavage Procedures Authorized in 2017	Expected Delayed Mortalities (assuming 100% of authorized are conducted)	"In-hand" Capture Mortalities Authorized in 2017	Total Mortalities Based on Authorized 2017 Take	Adult/subadult 5-year Average Annual Maximum Mortality Limit
Gulf of Maine	Penobscot	40.0	1.0	0.00	1.00	1.0
	Kennebec	184.3	4.6	0.25	4.86	6.9
	Androscoggin	0.0	0.0	0.25	0.25	1.0
	Sheepscot	0.0	0.0	0.25	0.25	1.0
	Piscataqua	0.0	0.0	0.25	0.25	1.0
	Merrimack	0.0	0.0	0.00	0.00	1.0
New York Bight	Taunton	0.0	0.0	0.00	0.00	1.0
	Pawcatuck	0.0	0.0	0.00	0.00	1.0
	Thames	0.0	0.0	0.25	0.25	1.0
	Connecticut	25.0	0.6	0.25	0.88	1.0
	Housatonic	0.0	0.0	0.00	0.00	1.0
	Hudson	557.0	13.9	3.50	17.43	24.0
	Delaware	330.9	8.3	2.00	10.27	10.4
Chesapeake Bay	Susquehanna	18.8	0.5	0.20	0.67	1.0
	Potomac	18.8	0.5	0.20	0.67	1.0
	James	77.0	1.9	0.40	2.32	4.2
	York	18.8	0.5	0.40	0.87	1.2
	Rappahannock	18.8	0.5	0.20	0.67	1.0
	Nanticoke	0.0	0.0	0.40	0.40	1.0
	Nottoway	27.4	0.7	0.00	0.68	1.0
Carolina	Roanoke	27.4	0.7	0.00	0.68	1.1
	Tar-Pamlico	0.0	0.0	0.00	0.00	1.0
	Neuse	0.0	0.0	0.00	0.00	1.0
	Cape Fear	0.0	0.0	0.00	0.00	1.0
	Waccamaw/ Pee Dee	0.0	0.0	0.00	0.00	1.0
	Black	0.0	0.0	0.00	0.00	1.0
	Santee	10.0	0.3	0.00	0.25	1.0
	Cooper	20.0	0.5	0.00	0.50	1.0
South Atlantic	ACE Basin	20.0	0.5	1.00	1.50	2.4
	Ashepoo	0.0	0.0	0.00	0.00	1.0
	Sampit	0.0	0.0	0.00	0.00	1.0
	Broad	0.0	0.0	0.00	0.00	1.0
	Savannah	57.8	1.4	1.00	2.45	6.0
	Ogeechee	48.5	1.2	1.00	2.21	3.3
	Altamaha	16.2	0.4	1.00	1.41	10.6
	Satilla	10.0	0.3	1.00	1.25	1.4
	St. Mary's	5.0	0.1	0.00	0.13	1.0
	St. John's	5.0	0.1	0.00	0.13	1.0

Table 18. Comparison of juvenile Atlantic sturgeon estimated delayed mortalities based on 2017 authorized invasive procedures plus authorized "in-hand" mortalities with 2017 maximum mortality limits by spawning stock.

DPS (name)	Spawning Stock	Internal Tagging and Gastric Lavage Procedures Authorized in 2017	Expected Delayed Mortalities (assuming 100% of authorized are conducted)	"In-hand" Capture Mortalities Authorized in 2017	Total Mortalities Based on Authorized 2017 Take	Juvenile 5-year Average Annual Maximum Mortality Limit
Gulf of Maine	Penobscot	4.0	0.2	0.20	0.40	1.0
Gulf of Maine	Kennebec	37.2	1.9	0.20	2.06	6.9
Gulf of Maine	Androscoggin	0.0	0.0	0.20	0.20	1.0
Gulf of Maine	Sheepscot	0.0	0.0	0.20	0.20	1.0
Gulf of Maine	Piscataqua	0.0	0.0	0.20	0.20	1.0
Gulf of Maine	Merrimack	0.0	0.0	0.00	0.00	1.0
New York Bight	Taunton	0.0	0.0		0.00	1.0
New York Bight	Pawcatuck	0.0	0.0		0.00	1.0
New York Bight	Thames	0.0	0.0	0.25	0.25	1.0
New York Bight	Connecticut	15.0	0.8	0.25	1.00	1.0
New York Bight	Housatonic	0.0	0.0		0.00	1.0
New York Bight	Hudson	496.8	24.8	6.50	31.34	34.5
New York Bight	Delaware	352.0	17.6	3.00	20.60	29.2
Chesapeake Bay	Susquehanna	0.0	0.0	0.10	0.10	1.0
Chesapeake Bay	Potomac	0.0	0.0	0.10	0.10	1.0
Chesapeake Bay	James	44.8	2.2	0.10	2.34	4.2
Chesapeake Bay	York	0.0	0.0	0.10	0.10	1.2
Chesapeake Bay	Rappahannock	0.0	0.0	0.10	0.10	1.0
Chesapeake Bay	Nanticoke	0.0	0.0	0.10	0.10	1.0
Chesapeake Bay	Nottoway	20.0	1.0	0.00	1.00	1.0
Carolina	Roanoke	21.0	1.1	0.00	1.05	1.1
Carolina	Tar-Pamlico	0.0	0.0	0.00	0.00	1.0
Carolina	Neuse	0.0	0.0	0.00	0.00	1.0
Carolina	Cape Fear	0.0	0.0	0.00	0.00	1.0
Carolina	Waccamaw/ Pee Dee	0.0	0.0	0.00	0.00	1.0
Carolina	Black	0.0	0.0	0.00	0.00	1.0
Carolina	Santee	10.0	0.5	0.00	0.50	1.0
Carolina	Cooper	10.0	0.5	0.00	0.50	1.0
South Atlantic	ACE Basin	10.0	0.5	1.00	1.50	2.4
South Atlantic	Ashepoo	0.0	0.0	0.00	0.00	1.0
South Atlantic	Sampit	0.0	0.0	0.00	0.00	1.0
South Atlantic	Broad	0.0	0.0	0.00	0.00	1.0
South Atlantic	Savannah	43.5	2.2	1.00	3.18	11.8
South Atlantic	Ogeechee	31.4	1.6	1.00	2.57	3.3
South Atlantic	Altamaha	16.2	0.8	1.00	1.81	10.6
South Atlantic	Satilla	10.0	0.5	1.00	1.50	13.2
South Atlantic	St. Mary's	10.0	0.5	0.00	0.50	1.0
South Atlantic	St. John's	5.0	0.3	0.00	0.25	1.0

Table 19. Comparison of adult/subadult shortnose sturgeon estimated delayed mortalities based on 2017 authorized invasive procedures plus authorized "in-hand" mortalities with 2017 maximum mortality limits by spawning stock.

Spawning Stock	Internal Tagging and Gastric Lavage Procedures Authorized in 2017	Expected Delayed Mortalities (assuming 100% of authorized are conducted)	"In-hand" Capture Mortalities Authorized in 2017	Total Mortalities Based on Authorized 2017 Take	Adult/subadult 5-year Average Annual Maximum Mortality Limit
St. John	0.0	0.0	0.00	0.00	108.0
Kennebecasis	0.0	0.0	0.00	0.00	16.5
Penobscot	70.0	1.8	0.60	2.35	1.0
Kennebec	140.0	3.5	0.60	4.10	57.0
Androscoggin	0.0	0.0	0.00	0.00	24.0
Merrimack	40.0	1.0	0.60	1.60	0.6
Connecticut	45.0	1.1	1.00	2.13	12.0
Hudson	205.0	5.1	4.00	9.13	366.0
Delaware	190.0	4.8	3.00	7.75	96.0
Potomac	10.0	0.3	0.00	0.25	1.0
James	10.0	0.3	0.00	0.25	1.0
Neuse	0.0	0.0	0.00	0.00	1.0
Cape Fear	0.0	0.0	0.00	0.00	0.6
Waccamaw/ Pee Dee	0.0	0.0	0.00	0.00	1.0
Santee	10.0	0.3	0.00	0.25	1.0
Cooper	20.0	0.5	0.00	0.50	1.2
ACE Basin	5.0	0.1	0.00	0.13	1.0
Savannah	30.0	0.8	2.00	2.75	13.4
Ogeechee	5.0	0.1	1.00	1.13	2.2
Altamaha	10.0	0.3	1.00	1.25	50.6
Satilla	5.0	0.1	0.00	0.13	0.4
St. Mary's	5.0	0.1	0.00	0.13	1.0
St. John's	5.0	0.1	0.00	0.13	1.0

the actual number of mortalities from sturgeon research conducted under the proposed action will be smaller than the maximum mortality limits for most river systems and in most years. As follows, we also expect that mortality levels as a proportion of the population size will be significantly lower than the relative maximum mortality limits of 0.4 percent, 0.6 percent, and 0.8 percent (of the estimated population size) for low, medium and high health category river systems, respectively.

6.3.2 Sturgeon Risk Analysis

6.3.2.1 Risks Associated with Lethal Take

As discussed above (*Sturgeon Exposure and Response Analysis* section), some activities authorized as part of the proposed action will likely increase the mortality risk for individual juvenile, subadult, and adult Atlantic and shortnose sturgeon. Two types of mortality are

Table 20. Comparison of juvenile shortnose sturgeon estimated delayed mortalities based on 2017 authorized invasive procedures plus authorized "in-hand" mortalities with 2017 maximum mortality limits by spawning stock.

Spawning Stock	Internal Tagging and Gastric Lavage Procedures Authorized in 2017	Expected Delayed Mortalities (assuming 100% of authorized are conducted)	"In-hand" Capture Mortalities Authorized in 2017	Total Mortalities Based on Authorized 2017 Take	Juvenile 5-year Average Annual Maximum Mortality Limit
St. John	0.0	0.0	0.00	0.00	108.0
Kennebecasis	0.0	0.0	0.00	0.00	16.5
Penobscot	2.0	0.1	0.60	0.70	1.0
Kennebec	2.0	0.1	0.60	0.70	57.0
Androscoggin	0.0	0.0	0.00	0.00	24.0
Merrimack	15.0	0.8	0.60	1.35	0.6
Connecticut	25.0	1.3	2.00	3.25	12.0
Hudson	120.0	6.0	1.00	7.00	366.0
Delaware	85.0	4.3	3.00	7.25	96.0
Potomac	0.0	0.0	0.00	0.00	1.0
James	0.0	0.0	0.00	0.00	1.0
Neuse	0.0	0.0	0.00	0.00	1.0
Cape Fear	0.0	0.0	0.00	0.00	0.6
Waccamaw/ Pee Dee	0.0	0.0	0.00	0.00	1.0
Santee	10.0	0.5	0.00	0.50	1.0
Cooper	20.0	1.0	0.00	1.00	1.2
ACE Basin	5.0	0.3	0.00	0.25	1.0
Savannah	20.0	1.0	2.00	3.00	13.4
Ogeechee	10.0	0.5	1.00	1.50	2.2
Altamaha	10.0	0.5	1.00	1.50	50.6
Satilla	0.0	0.0	0.00	0.00	0.4
St. Mary's	0.0	0.0	0.00	0.00	1.0
St. John's	0.0	0.0	0.00	0.00	1.0

anticipated: "in-hand" and "delayed." "In-hand" mortalities will be observed and reported by permit holders to the Permits Division. These include mortalities resulting from capture and handling, a negative reaction to the use of anesthesia, or an incorrectly performed invasive procedure. Sturgeon exposed to implantation of internal telemetry tags or gastric lavage will have an increased risk of "delayed" mortality due to post-procedural complications. As part of our risk analysis, we evaluate the anticipated sturgeon mortality resulting from the proposed action, and the likely effects those mortalities may have on the viability of Atlantic and shortnose sturgeon populations as listed under the ESA.

Mortality of Atlantic and shortnose sturgeon will be limited (i.e., maximum mortality limits) in the proposed action at the species, river system, and life stage (i.e., early life stages, juvenile and adult/subadult) level. Mortality limits represent the maximum number of sturgeon that can be killed annually as part of the proposed action; as discussed below, the actual number of sturgeon mortalities resulting from the proposed action may be considerably smaller. Maximum mortality limits are dynamic and can fluctuate from year to year based on new information regarding sturgeon population health and/or status and estimated population size. Our risk analysis takes into account the dynamic nature of the maximum mortality limits and other adaptive features of the proposed Program discussed throughout this opinion.

Early Life Stage Sturgeon Mortality

Although sturgeon are broadcast spawners having very low survival rate of early life stages, the survival from egg to juvenile life stages remains a likely critical aspect in determining the strength of the year class (COSEWIC 2005). Therefore, it is important to be conservative when analyzing the impacts of authorizing the directed take of sturgeon eggs and larvae. As part of the proposed Program, the Permits Division proposes to authorize the lethal take of up to 16,000 Atlantic sturgeon early life stage individual (i.e., eggs and larvae) and 1,080 shortnose sturgeon early life stage individuals annually within each river system. These take levels were based on a fixed proportion (four percent) of the estimated annual female fecundity using the lower value range found in the scientific literature. Atlantic sturgeon have observed egg production ranging from 400,000 to four million eggs per spawning year, but could be as large as eight million eggs based on gonad to body weight ratios (Dadswell 2006; Smith et al. 1982; Van Eenennaam and Doroshov 1998). Fecundity estimates for shortnose sturgeon typically range from 27,000 to 208,000 eggs/female (Dadswell et al. 1984). The proposed approach for authorizing sturgeon early life stages mortality is highly conservative since it assumes a single female spawner for an entire river system, a lower bound estimate of fecundity which may actually be up to an order of magnitude higher, and a relatively small mortality rate (four percent) that is well below early life stages natural mortality rates. Therefore, while the authorized lethal take of early life stages as part of the proposed action directly increases mortality for these stages, and may result in a minor decrease in reproduction for one or several adult sturgeon, it is not likely to affect the survival or recovery of Atlantic and shortnose sturgeon river populations or the species/DPSs they comprise.

The actual number of early life stage lethal takes resulting from the proposed action will likely be considerably smaller than the maximum annual mortality limit. From 2006-2016, the Permits Division authorized the lethal take of 8,372 shortnose sturgeon early life stages (across all river systems) but only 323 were actually reported as taken. In their 2017 permit applications, sturgeon researchers requested a total of 2,470 Atlantic sturgeon and 780 shortnose sturgeon early life stage takes annually across all river systems combined. Even if 100 percent of authorized early life stages takes actually occur, which is highly unlikely given past history, they would still be well below the conservative limits established in the early life stages maximum mortality limits.

Juvenile, Subadult and Adult Sturgeon Mortality

In this subsection, we first evaluate the risk to Atlantic and shortnose sturgeon river populations, species and DPSs if the maximum juvenile and subadult/adult relative maximum mortality limits (or default levels for "unknown" populations) that could be authorized by the proposed action are fully attained. We then evaluate the risk associated with exceeding relative annual maximum mortality limits due to uncertainty associated with status matrix inputs used to calculate the maximum mortality limits or uncertainty in estimating delayed mortality from invasive procedures.

Despite the longevity of individual sturgeon, the viability of sturgeon populations is highly sensitive to increases in juvenile mortality that result in chronic reductions in the number of subadults that recruit into the adult breeding population (Anders et al. 2002; Gross et al. 2002; Secor et al. 2002). Several authors have also demonstrated that sturgeon populations, shortnose in particular, are more sensitive to adult mortality than other species of fish (Boreman 1997; Gross et al. 2002; Secor et al. 2002). The mortality of any individual fish from a population represents the loss of 100 percent of that fish's reproductive potential. For long-lived species, such as Atlantic and shortnose sturgeon, mortality of juveniles or subadults affects future reproductive potential and could have effects on a population for decades. Given their large body size and high fecundity, mortality of adult sturgeon can result in negative population levels impacts, particularly in very small Atlantic and shortnose sturgeon populations typical of many river systems throughout their respective ranges. Therefore, it is important to analyze the impact of juvenile, subadult and adult anthropogenic mortality on the viability of sturgeon populations.

For juvenile and adult/subadult sturgeon, the proposed relative annual maximum mortality limits are 0.4 percent, 0.6 percent, and 0.8 percent of the estimated population size for low, medium and high health category river systems, respectively. Relative annual maximum mortality limits represent the average annual maximum mortality as a proportion of the population size over any given five-year period (i.e., five-year moving average). For "unknown" river systems, where there is not enough information to calculate a health index and/or there is no estimated population size, the maximum mortality limit will default to one sturgeon per year for a given species and life stage. The five-year average annual sturgeon maximum mortality limits proposed for 2017 are shown by species, river system and life stage in Tables 17-20. Maximum mortality limits can change from year to year based on new information as part of the adaptive management approach of the proposed action. In addition to the five-year average annual mortality limit, juvenile and the adult/subadult maximum mortality limits would allow for a mortality buffer in any single year, which essentially doubles the mortality limit. For any single year the proposed relative maximum mortality limits (which include the mortality buffers) are 0.8 percent, 1.2 percent, and 1.6 percent of the estimated population size for high, medium and low health category river systems, respectively. The single year mortality limit (with buffer) in "unknown" river systems will be two fish. Thus, use of a mortality limit buffer could result in the removal of a higher proportion (up to twice) of a given sturgeon population in any single year.

Empirical studies evaluating the effects of varying levels of anthropogenic mortality on sturgeon populations are lacking. Previous model-based studies have used basic principles of fishery science to approximate tolerable mortality rates to ensure survival and/or recovery based on sturgeon life history parameters including female fecundity, age and growth, and natural mortality rate. Although these studies were addressing the effects of sturgeon bycatch in commercial fisheries, the basic concepts used to model a targeted mortality rate still apply to mortality from research activities. Assuming a population is composed of equal numbers of males and females, each egg produced would need to survive and produce two viable eggs just to keep the population trend at zero (no increase or decrease). Goodyear (1993) suggests that to maintain a steady population at least 20 percent of the population must be of spawning age; to promote population growth and recovery, a more conservative estimate of 50 percent of the population must be of spawning age (Boreman 1984). Boreman (1997) evaluated the total lifetime potential egg production of an individual female from the Hudson River to determine the loss of potential fecundity caused by Atlantic sturgeon bycatch in commercial fisheries. Based on the approximate spawning population thresholds above (i.e., 20 percent for stability, 50 percent for recovery), Boreman estimated that a five percent fishing mortality level or lower would allow for population growth and recovery. This analysis assumes there are no other significant sources of mortality besides natural mortality and fishing mortality, which of course is an invalid assumption for many of the sturgeon populations considered in this opinion (see *Environmental Baseline*). Based on a yield and egg per recruit model, Kahnle et al. (1998) estimated that a commercial bycatch fishing mortality rate of three percent (F = 0.03) would keep the Hudson River Atlantic sturgeon population stable or increasing. As a caveat, both of these analyses were focused on the Hudson River Atlantic sturgeon population; information and assumptions used to develop these models are not necessarily valid for other Atlantic sturgeon river populations or for shortnose sturgeon populations. In addition, these models were based on the limited sturgeon data available in the late 1990's; model outputs may differ if updated with more recent available data. Despite the identified caveats and shortcomings, these studies still provide us with some indication of the level of anthropogenic mortality sturgeon populations could potentially endure while still allowing for population growth and recovery.

Another approach for evaluating the relative impact of anthropogenic stressors on fish populations is to compare anthropogenic mortality with estimated natural mortality. For shortnose sturgeon the annual natural mortality rate has been estimated at 0.13 (NMFS 1998). For Atlantic sturgeon annual natural mortality rate has been estimated to be approximately 0.125 for juvenile and subadult fish aged 2-10 (<150 cm), and 0.07 for adults (Kahnle et al. 2007; Kocik et al. 2013). Natural mortality rates are often high for juvenile and young subadult fish because they are vulnerable to predation, have a limited tolerance for environmental extremes, and are subject to considerable intraspecific competition. Therefore, while the loss of a juvenile sturgeon is the loss a 100% of that fish's reproductive potential, it may not actually have any effect on the reproductive potential of the future adult population.

The proposed relative annual maximum mortality limits (i.e., 0.4, 0.6, and 0.8 percent of population) were designed to be conservative while still allowing for the level of research necessary to aid in the recovery of sturgeon species and DPSs. Mortality of juvenile, subadult, and adult sturgeon resulting from the proposed action will likely have some adverse effects on Atlantic and shortnose sturgeon populations. Sturgeon populations most at risk from anthropogenic mortality are those that are small, experiencing a declining population trend, and facing significant ongoing threats. As part of the proposed action, such populations would have a health category rating of "low," which translates to a relative annual maximum mortality limit of 0.4 percent of the population size. This upper limit on mortality allowed under the proposed action is an order of magnitude smaller than modeled target mortality levels (3 to 5 percent) to allow for growth and recovery of the Hudson River Atlantic sturgeon population (Boreman 1997; Kahnle et al. 1998). The maximum mortality limit for river systems in poor health is also significantly lower than estimated rates of natural mortality for these species (~ 13 percent for shortnose sturgeon; range from 7-13 percent for Atlantic sturgeon) (Kahnle et al. 1998; Kahnle et al. 2007; Kocik et al. 2013; NMFS 1998). Healthier river populations (i.e., health categories "medium" and "high") with population trends either stable or increasing, and facing no significant threats would be at a lower risk due to anthropogenic mortality. Although the proposed relative annual maximum mortality limit rates (0.6 and 0.8 percent) for these populations are higher, these limits are still well below the target mortality rates proposed by Boreman (1997) and Kahnle et al. (1998), and are significantly smaller than estimated natural mortality rates.

The mortality limit of one fish for "unknown" systems is a maximally conservative limit while still allowing for some research activities to occur. Basic information (e.g., spawning occurrence and time of year, population size, movement and mixing) about these understudied sturgeon populations may be essential for the survival and recovery of sturgeon species and DPSs. The Permits Division will be conservative in authorizing invasive procedures that could result in delayed mortality (i.e., internal tagging or gastric lavage) in "unknown" systems. If an "in-hand" mortality is reported in an "unknown" system, research activities would cease until the Permits Division evaluates the incident and determines what activities could continue given the maximum mortality limits. We anticipate that the number of "unknown" systems will decrease over time as more data are collected by sturgeon researchers working in these systems.

Use of the proposed mortality limit buffer could potentially double the five-year average mortality limits in any given single year. As part of the proposed action the Permits Division will use mortality limit buffers sparingly, and only as a short-term measure in cases where the maximum mortality limit was unexpectedly exceeded due circumstances beyond its control. Any use of a mortality limit buffer will be off-set by reduced mortalities (below the maximum mortality limit level) in subsequent years to ensure that sturgeon research activities do not result in exceeding average annual maximum mortality limits over any five-year period (i.e., five-year moving average). Thus, any detrimental impacts resulting from use of a mortality limit buffer will likely be temporary and short-term. Given the life history of Atlantic and shortnose sturgeon (i.e., long-lived, late maturation, high fecundity), such short-term impacts are not expected to have a significant effect on survival or recovery at the population, DPS or species level. Therefore, it is unlikely that use of a mortality buffer will result in any significant long-term impacts on the survival or recovery of the population beyond the impact of the mortality limit without the buffer. In addition, based on our analysis above, comparing 2017 authorized sturgeon research mortality levels with prescribed 2017 upper maximum mortality limits, we predict that mortality limit buffers would have very limited use since authorized mortality levels are expected to remain well below the maximum mortality limits in most cases.

The proposed approach for establishing sturgeon maximum mortality limits includes the following conservative assumptions that minimize the risk associated with exceeding the relative annual maximum mortality limits:

1. <u>Derived population sizes based on estimated effective population sizes</u>

   The maximum mortality limits in terms of numbers of fish, as shown in these Tables 17-20, likely represent a smaller proportion of the population than the relative (i.e., 0.4, 0.6, and 0.8) annual maximum mortality limits due to conservative assumptions made in estimating population sizes used to create the maximum mortality limits. For ten Atlantic sturgeon river populations, adult population size was derived from the estimated effective population size, since empirical census population estimates were unavailable. The ratio empirical population size to effective population size (10:1) used for this conversion was based on multiple studies of relatively healthy fish populations (Frankham 1995). This ratio is likely conservative for exploited or at-risk fish populations (Nelson and Soule 1987), and therefore may result in derived sturgeon population sizes that are conservatively small.

2. <u>Estimated population sizes do not account for subadults</u>

   Population sizes (either derived or empirical) used for Atlantic sturgeon adult/subadult maximum mortality limits are also likely underestimated because they do not account for subadult populations. Therefore, while subadult mortalities will be included with adult mortalities for purposes of the proposed maximum mortality limits, they are not included in the population estimates used to establish the adult/subadult mortality limits. Kocik et al. (2013) estimated the mean total coast-wide Atlantic sturgeon abundance from 2006-2011 was 417,934 fish based on the ASPI model, and 139,935 fish based on dividing observed discards by the ASPI exploitation rate. Models based on NEAMAP survey data from 2007-

2012 estimated ocean abundances ranging from about 34,000 to 340,000 fish, depending on assumptions about gear efficiency. These models, which account for both migrating adults and subadults subject to capture in ocean environments, suggest that the derived population sizes used for the adult/subadult Atlantic sturgeon maximum mortality limits are conservatively small.

3. Use of estimated adult population size as proxy for juvenile population size

Population sizes used to create juvenile maximum mortality limits are also conservative. There is limited available information on juvenile population sizes of Atlantic and shortnose sturgeon and abundances are constantly changing as cohorts mature. For purposes of creating juvenile sturgeon maximum mortality limits, if a juvenile population estimate is not available for a particular river system, the estimated adult population size would be used as a proxy. This is a conservative assumption since in fish populations juveniles typically outnumber adults, particularly in unhealthy populations with small numbers of adults. Thus, most of the juvenile maximum mortality limits would be established based on a population size that is likely conservatively small compared to the actual juvenile population size.

4. Use of conservative delayed mortality rates for highly invasive procedures

Available information to evaluate delayed mortality associated with implanting internal tags in Atlantic and shortnose sturgeon are limited. Estimating delayed mortality due to tagging from reported sturgeon telemetry tracking results can be difficult since there may be multiple reasons a tag cannot be located (e.g., fish moved out of range, tag expulsion, tag malfunction, natural mortality, or other source of mortality). As part of the proposed action, delayed mortality rates of 2.5 percent for subadults/adults and five percent for juveniles will be applied to authorized procedures that could result in delayed morality (i.e., internal tagging and gastric lavage). The proposed subadult/adult delayed mortality rate is based on studies that conservatively assumed tags not detected beyond 90 days after tagging represent fish that died as a result of tagging (J. Kahn, NMFS OPR unpublished data collected from 2013-2016; D. Fox, Delaware State University, unpublished data collected 2009-2013). The 2.5 percent mortality rate proposed for internal tagging of subadult/adult sturgeon is likely a conservatively high estimate of the post-release mortality rate since it does not fully account for alternative reasons for why an internal tag may not be detected. In addition, another study of cultured shortnose sturgeon recorded no mortality from internal tagging over a three month period (Collins et al. 2002). Since there are no studies on sturgeon delayed mortality rates from gastric lavage, the same mortality rate will be used for lavage as that proposed for internal tagging. This is also likely a conservative assumption since, if done using proper protocols, lavage is considered a less invasive procedure than internal tagging. Lacking information on delayed mortality rates for juveniles, the delayed mortality rate proposed for subadults/adults will be doubled for juveniles to account for their smaller body size, which has been associated with increased risk from invasive procedures. The five percent delayed mortality rate proposed for juvenile may also be a conservatively high estimate since juvenile sturgeon used for these research procedures will still be relatively large (> 300 mm) and hardy fish.

Thus, it is likely that the estimated population sizes based on the assumptions (numbers 1 through 3) above used to create sturgeon maximum mortality limits are conservatively estimated low. This would result in mortality limits of numbers of fish that represent a smaller proportion of the population than the relative annual maximum mortality limits of 0.4, 0.6, and 0.8. In addition, it is likely that the proposed delayed mortality rates applied to internal tagging and gastric lavage procedures are conservatively estimated high due to the assumptions described above. This will likely result in conservatively high estimates of delayed mortalities in terms of both numbers of fish killed and the relative proportion these numbers represent of the population. Thus, the risk associated with exceeding the relative annual maximum mortality limits due to the proposed delayed mortality rates is likely very small considering the conservative assumptions associated with these rates. Based on the best available information on sturgeon or appropriate surrogates (including annual permit holder reports), the Permits Division will continually update and improve on the estimated delayed mortality rates that will be applied to authorized procedures. Therefore, improvements in estimated delayed mortality rates over time should further reduce any risk associated with exceeding the relative annual maximum mortality limits due to delayed mortality.

In summary, based on our risk analysis, we determine that sturgeon mortality resulting from the proposed action will not reach levels that significantly affect the viability of Atlantic or shortnose sturgeon populations as listed under the ESA. This conclusion is based on the following: (1) relative annual maximum sturgeon mortality limits, as proposed in this action, are significantly below target mortality rates for sturgeon population growth and recovery reported in the literature and estimated natural mortality rates, (2) it is unlikely that use of a mortality buffer will result in any significant long-term impacts on the survival or recovery of the population beyond the impact of the mortality limit without the buffer because the maximum mortality limit will be adjusted in subsequent years if the buffer is accessed, (3) conservative assumptions regarding sturgeon population sizes that likely result in maximum mortality limits in terms of numbers of fish that represent a smaller proportion of the population than the relative annual maximum mortality limits, (4) conservative assumptions regarding delayed mortality rates that likely result in conservatively high estimates of delayed mortalities in terms of both numbers of fish killed and the relative proportion these numbers represent of the population, and (5) the proposed action is designed to be conservatively protective of each subpopulation (or spawning stock) within the species or DPS.

6.3.2.2 Risks Associated with the Effects of Sub-lethal Take

Based on our Sturgeon Exposure and Response Analysis above, we determine that sub-lethal effects on Atlantic and shortnose sturgeon resulting from research activities authorized under the proposed action will be minimal, short-term, and are not likely to result in any reduced fitness or loss of fecundity to individual fish. Since sub-lethal effects are not likely to result in reduced fitness or fecundity of individuals, it follows that sub-lethal effects from research activities are not likely to negatively impact Atlantic and shortnose sturgeon populations. These conclusions can be reached as long as all sampling protocols, mitigation measures, and any other required conditions of the sturgeon research permit are followed by all permit holders. In addition, as part of the adaptive management approach that is an integral part of the proposed Program, the Permits Division will continuously monitor and evaluate the sub-lethal effects of authorized activities. If the sub-lethal effects associated with a particular activity are greater than anticipated, the Permits Division will reevaluate the authorization of the activity in permits and consider additional mitigation measures as necessary.

Although the Permits Division will not establish annual limits of sub-lethal take of Atlantic and shortnose sturgeon, by proxy sturgeon captures are limited in effect by the proposed maximum mortality limits. That is, if an annual mortality limit is reached for a particular species, river system, and life stage no more captures (and therefore no more procedures) will be authorized for the rest of the year. In addition, consistent with its obligations under the ESA, the Permits Division will effectively limit captures and procedures to only those it determines are necessary to achieve the objectives of research that will aid in the recovery of ESA-listed species.

In summary, we do not anticipate the sub-lethal effects resulting from sturgeon research activities are likely to reduce fitness in individual fish, or the viability of sturgeon populations as listed under the ESA. Therefore, we determine that the authorized sublethal take of sturgeon as part of the proposed action is not likely to affect the survival or recovery of Atlantic and shortnose sturgeon river populations or the species/DPSs they comprise.

6.3.3 Atlantic Salmon Exposure and Response Analysis

GOM DPS Atlantic salmon adults return to spawn in river systems shared with Atlantic and shortnose sturgeon. Adult Atlantic salmon may be in freshwater from May through October. Adults move upstream at temperatures below 23°C covering approximately four river kilometers per day, making them susceptible to research vessel interactions and capture in sampling gear. Salmon eggs and alevins may be susceptible to capture in gears used to capture Atlantic or shortnose sturgeon early life stages. Juvenile salmon spend multiple years rearing in freshwater before smolting and outmigrating to the marine environment. During this time, juveniles are susceptible to capture in both small mesh gill nets and trawls. The juveniles tend to congregate in water less than three meters deep at the mouths of tributaries. Atlantic and shortnose sturgeon use this habitat as refuge during parts of the year. Upon completion of the physiological transition to salt water, post-smolt Atlantic salmon grow rapidly and move in small schools, loosely-aggregated, close to the surface (Dutil and Coutu 1988). After entering into the nearshore waters of Canada, the U.S. post-smolts become part of a mixture of stocks of Atlantic salmon from various North American streams. Results from a 2001-2005 post-smolt trawl survey in Penobscot Bay and the nearshore waters of the GOM indicate that Atlantic salmon post-smolts are prevalent in the upper water column (Sheehan et al. 2005). Atlantic salmon use the offshore locations as a migratory route and for foraging.

Most of the GOM DPS-origin salmon spend two winters in the ocean before returning to streams for spawning. The sampling gear used to target Atlantic sturgeon operates on or very near the bottom. During their stay in the marine environment, Atlantic salmon could interact with Atlantic sturgeon sampling gear, but the risk of that is much lower than when in freshwater environments. During this stage, vessels conducting sturgeon sampling could strike Atlantic salmon or salmon could be pulled through the propellers of vessels.

Impacts from vessel interactions are expected to be minimal to individual Atlantic salmon. The presence of sturgeon research vessels may disturb salmon resulting in their movement away from the vessel for a short time. Reactions may include a brief startle response, diving, submerging, or attempting to evade the vessel or research personnel. Researchers are expected to be vigilant and proceed carefully to minimize risk of vessel strike and unnecessary disturbance when Atlantic salmon may be in the area. Based on the anticipated responses, any disruptions are expected to be temporary in nature, with animals resuming normal behaviors shortly after the exposure. No reduction in fitness or overall health of individual GOM DPS Atlantic salmon is anticipated due to the presence of research vessels in areas occupied by this species. Research vessels conducting sturgeon sampling could potentially collide with Atlantic salmon in the upper water column. The threats assessment done for Atlantic salmon as part of the 2009 ESA listing of the expanded GOM DPS did not list vessel strikes as a high priority threat. In addition, no interactions between sturgeon research vessels and GOM Atlantic salmon have been documented in the past. Overall, we determine that sturgeon research vessels represent an extremely small risk to the GOM DPS.

If an Atlantic salmon is taken as part of the proposed action it is most likely to be caused by entanglement in gillnets. Atlantic salmon mortality when captured in gillnets is usually the result of suffocation, exacerbated by high water temperatures and/or low DO. Wilkie et al. (1997) showed that salmon suffered 30 percent mortality when stressed for just 6 minutes in 23ºC water. Elevated water temperatures also make salmon more vulnerable to delayed mortality associated with their capture, which can occur for up to three days after being released (Wilkie et al. 1997). Atlantic salmon also suffer from impaired respiratory abilities when DO is below 5mg/L (Kazakov and Khalyapina 1981). Salmon generally occupy the upper portions of the water column and are much less likely to be captured in trawls than in gill nets.

Historic data from 1989 through 2011 show that there have been 13 observed subadult Atlantic salmon interactions with otter trawls or gillnets used in the federal fisheries along the northeastern U.S. Coast. Lacking genetic information of the fish involved in these interactions, and based on the known distribution of GOM DPS Atlantic salmon, taking a precautionary approach, we are assuming these interactions were all GOM DPS Atlantic salmon. Past sturgeon sampling surveys in Maine, Connecticut, and New Brunswick have reported very low bycatch of Atlantic salmon using large mesh gill nets (NMFS 2017). Although high mortality rates have been reported for salmon captured commercial gillnets, mortality risk can be effectively reduced when appropriate mitigation measures are implemented (Farrell et al. 2001). NMFS has implemented mitigation measures to minimize Atlantic salmon interactions and mortalities including short soak times, regularly checking nets, making salmon staging areas and known areas of salmon occurrence off-limits to gill net sampling, immediately releasing salmon, and taking temperature and DO measurements before sampling an area (see Section 4.1.4 and Appendix C). These mitigation measures are expected to reduce exposure to capture and mortality rates associated with captured Atlantic salmon.

Restrictions on sampling in particular areas where Atlantic salmon are likely to occur substantially reduce the likelihood of interaction with sampling gear. In the Kennebec system, Atlantic salmon are known to congregate near the confluences of the Kennebec River and Bond Brook, and below Lockwood Dam, and have also been encountered in the following locations: Sand Island @ < 43.914465, -69.727821>; Pine Island @ < 43.914465, -69.727821>; and Fort Halifax Park @ <44.54482, -69.627271>. In the Penobscot system, Atlantic salmon are known to occur near the confluences of the Penobscot River and Cove Brook, Kenduskeag River, Ducktrap River, and Meadow Brook and have been encountered in shallower, non-channel waters of Oak Point Cove @ 44.667005, -68.822994 and Graham Station @ 44.821459, -68.708721.

Mitigation measures regarding gear specifications can also reduce the likelihood of Atlantic salmon being captured in sturgeon sampling gear. Gillnets with mesh sizes smaller than six inches are more likely to capture migrating adult salmon compared to smaller mesh nets. In all GOM rivers with runs of Atlantic salmon (with exception in the Penobscot River), gillnets having greater than six inch mesh may only be fished in main channels of rivers and bays of the action area at depths of 20 feet or greater. Such nets may also be fished in areas characterized as mudflats, off main channels in waters less than ten feet depth. Only 12-inch mesh gillnets may be fished on the Penobscot River from the Waterworks at the site of the former Bangor Dam upstream to the form Veazie Dam site prior until October 1 of each permit year. From October 1 until December 31, 6-inch mesh or greater gillnets may be fished in the capture reach at anchored depths of less than 20-feet of water for one-half hour duration or less; and only when tagged Atlantic salmon are not present as determined by using available direct telemetry monitoring of Atlantic salmon.

Despite the mitigation measures designed to reduce the probability of interactions with sturgeon research gear, it is probable that some incidental take of Atlantic salmon will occur. We estimate that the proposed action will result in death of no more than two adult and ten other life stage (i.e., eggs, alevins, parr, and smolts) GOM DPS Atlantic salmon annually. To arrive at this estimate we considered the history of sturgeon research interactions with Atlantic salmon, the mitigation measures in place to avoid future interactions, and the potential future GOM DPS population growth that could increase the risk of exposure to sturgeon research sampling gear.

6.3.4 Atlantic Salmon Risk Analysis

Lethal interactions would reduce the number of GOM DPS Atlantic salmon, compared to their numbers in the absence of the proposed actions, assuming all other variables remained the same. Lethal interactions would also result in a potential reduction in future reproduction, assuming some individuals would be females and would have otherwise survived to reproduce. A lethal capture of an adult female GOM DPS Atlantic salmon in gillnet or bottom trawl gear would remove this level of reproductive output from the species. Lethal interactions with sturgeon capture gear may occur in the GOM DPS spawning rivers that overlap with sturgeon research. Whether the reductions in numbers and reproduction of this species would appreciably reduce its likelihood of survival depends on the probable effect the changes in numbers and reproduction would have relative to current population sizes and trends.

The observed declines in Atlantic salmon suggests that the combined impacts from ongoing activities described in the *Environmental Baseline, Cumulative Effects,* and the *Status of ESA-Listed Species* (including those activities that occur outside of the action area of this Opinion) are continuing to cause the population to deteriorate. For the population to remain stable, Atlantic salmon must replace themselves through successful reproduction at least once over the course of their reproductive lives, and at least one offspring must survive to reproduce itself. If the survival rate to maturity is greater than the mortality rate of the population, the loss of breeding individuals would be exceeded through recruitment of new breeding individuals from successful reproduction of Atlantic salmon that were not seriously injured or killed.

The most recent data available on the population trend of Atlantic salmon indicate that their abundance within the range of the GOM DPS has been generally declining since the 1800s (Fay et al. 2006). Contemporary estimates of abundance for the entire GOM DPS have rarely exceeded 5,000 individuals in any given year since 1967, and appear to have stabilized at very low levels since 2000 (Fay et al. 2006). After a period of slow population growth between the 1970s and the early 1980s, adult returns of salmon in the GOM DPS peaked around 1985 and declined through the 1990s and early 2000s. Adult returns have been increasing again over the last few years. The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s, marine survival rates decreased, leading to the declining trend in adult abundance observed throughout 1990s and early 2000s. The increase in the abundance of returning adult salmon observed between 2008 and 2011 may be an indication of improving marine survival. Adult returns for the GOM DPS remain well below conservation spawning escapement (CSE) goals that are widely used (ICES 2015) to describe the status of individual Atlantic salmon populations. When CSE goals are met, Atlantic salmon populations are generally self-sustaining. When CSE goals are not met (i.e., less than 100%), populations are not reaching full potential; and this can be indicative of a population decline. For all GOM DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below CSE levels required to sustain themselves (Fay et al. 2006), which is further indication of their poor population status.

While the abundance trend information for Atlantic salmon is either stable or declining, we believe the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on that trend. We anticipate no more than two GOM Atlantic salmon adult mortalities annually due to the proposed action. This represents about 0.2 percent of the estimated adult returns in 2015, and about 0.4 percent of the lowest value of estimated adult returns (i.e., 405 fish in 2014) over the past several decades (USASAC 2016). The anticipated mortalities represent an even smaller proportion of the number of adult Atlantic salmon that are stocked in Maine rivers every year (e.g., 3,066 in 2015). Similarly, we anticipate no more than ten mortalities of other life stages of GOM Atlantic annually due to the proposed action. This represents only a fraction of the number of early life stage GOM Atlantic salmon stocked annually (e.g., numbers stocked in 2015 were 531,000 eggs, 1,538,000 fry, 464,500 parr, and 375,600 smolt) (USASAC 2016). Similarly, we do not anticipate any long-term adverse effects on either individual fish or the GOM DPS resulting from the capture and live release of Atlantic salmon by sturgeon researchers.

Recent efforts to help Atlantic salmon recover include hatchery supplementation, dam removal, improving road crossings that block passage or degrade stream habitat, protecting riparian corridors, reducing the impact of irrigation water withdrawals, limiting effects of recreational and commercial fishing, reducing the effects of finfish aquaculture, outreach and education, and research activities. Improving the survival of Atlantic salmon in the marine environment is an important part of meeting the objective of GOM DPS Atlantic salmon recovery.

The proposed research activities have numerous mitigation measures intended to reduce the probability of interaction and to minimize the probability of mortality in the event of interactions. In summary, there is no indication that the anticipated small amount of Atlantic salmon take (lethal or sublethal) resulting from sturgeon research activities poses a threat to the recovery of the GOM DPS of Atlantic salmon.

6.3.5 Smalltooth Sawfish Exposure and Response Analysis

Smalltooth sawfish are birthed in shallow, estuarine habitats. They spend most of their lives in shallow, nearshore areas, occasionally moving into rivers, but rarely to salinities under 15-18 parts per thousand. Their populations are primarily located in southern Florida and they prefer warm (22-28°C), coastal waters and tropical seas. Historically, they ranged as far north as North Carolina during warmer times of the year. With their current abundance, the population is primarily restricted to the southern tip of Florida, but if their population increases and expands from this core area, it is possible some individuals will migrate up the Atlantic Coast. These migrations along the coast and even into lower parts of some rivers could result in interactions with sturgeon research activities.

Reports of smalltooth sawfish becoming entangled in fishing nets are common in early literature from areas where they once common, but are now rare, if not extirpated, including Florida (Snelson 1981), Louisiana (Simpfendorfer 2002), and Texas (Baughman 1943). Henshall (1894) noted that the smalltooth sawfish "does considerable damage to turtle nets and other set nets by becoming entangled in the meshes and is capable of inflicting severe wounds with its saw, if interfered with." Research on Atlantic sturgeon may result in the capture of smalltooth sawfish when sampling in estuarine and marine habitats. Sampling for shortnose sturgeon is not likely to take place in areas that overlap with smalltooth sawfish. Atlantic sturgeon gillnets and trawls operated in northern Florida and throughout Georgia are the most likely to catch a smalltooth sawfish. The likelihood of sturgeon research gear interacting with sawfish becomes increasingly more remote as you move north up the coast. There have been no smalltooth sawfish captured incidentally by sturgeon research gear since Atlantic sturgeon permits were first issued in 2012. There are also no records of shortnose sturgeon researchers catching smalltooth sawfish since shortnose sturgeon were listed in 1967.

Impacts from vessel interactions are expected to be minimal to individual smalltooth sawfish. The presence of a sturgeon research vessel may disturb sawfish resulting in their movement away from the vessel for a short time. Reactions may include a brief startle response, diving, submerging, or attempting to evade the vessel or personnel. Researchers are expected to be vigilant and proceed carefully to minimize risk of vessel strike and unnecessary disturbance when sawfish may be in the area. Based on the anticipated responses, any disruptions are expected to be temporary in nature, with animals resuming normal behaviors shortly after the exposure. No reduction in fitness or overall health of individual smalltooth sawfish is anticipated due to the presence of research vessels in areas occupied by this species. As with sturgeon and salmon, sturgeon research vessels may collide with smalltooth sawfish. While improbable, it is possible that a larger vessel could pull an adult smalltooth sawfish through its propeller. However, there have been no reported sawfish interactions with sturgeon research vessels in the past. Therefore, we determine that sturgeon research vessels represent an extremely small risk to smalltooth sawfish. Although a ship strike of smalltooth sawfish is extremely unlikely, if this occurs the outcome would likely be death.

The gillnets and trawls proposed for use in sturgeon research can result in mortality to smalltooth sawfish as seen through years of incidental captures in commercial fisheries (Simpfendorfer and Wiley 2005). Much of the smalltooth sawfish mortality in commercial fishing operations was due to the difficulty of removing smalltooth sawfish from fishing gear without damaging the gear. This often meant lethal removal of the saw before returning the fish to the water to starve to death, or killing the sawfish in the net and dropping the carcass overboard. The Permits Division has implemented the following mitigation measures designed to minimize adverse effects and the risk of mortality if a sawfish is captured incidentally:

- Researchers operating in areas where sawfish are present are required to be trained by a member of the NMFS sawfish recovery team to discuss proper handling procedures.
- When attempting to handle and release an incidentally captured sawfish, researchers must use caution and follow safe-handling procedures specified in the NMFS Sawfish Handling and Release Guidelines.
- Researchers must keep the fish in the water at all times and cutting the net from the rostrum and body of the animal (no attempts should be made to disentangle the rostrum from the net).
- Adverse interactions with sawfish should be documented, including any pertinent details of the interaction (e.g., gear type, what was done to handle and release the animals, location, date, size, water and air temperatures, and photos if possible).
- In the event a smalltooth sawfish is incidentally captured or harmed by research activities, all activities are to be suspended until the Permits Division has granted approval to continue research.

We estimate that the proposed action will result in the death of no more than two adult smalltooth sawfish annually. To arrive at this estimate we considered the history of sturgeon research interactions with smalltooth sawfish, the mitigation measures in place to avoid future interactions, and the potential future smalltooth sawfish population growth and range expansion that could increase the risk of exposure to sturgeon research sampling gear. Handling and restraining smalltooth sawfish may cause short-term stress responses, but those responses are not likely to result in pathologies because of the short duration of the handling. If smalltooth sawfish are not killed by being captured in gill nets or trawls (i.e., sublethal take), NMFS expects that individual smalltooth sawfish would normally experience no more than short-term stresses as a result of handling and release. No injury would be expected from these activities.

6.3.6 Smalltooth Sawfish Risk Analysis

The abundance of smalltooth sawfish in U.S. waters has decreased dramatically over the past century. However, recent information indicates the smalltooth sawfish population is likely stable or increasing (Carlson and Osborne 2012; Carlson and Simpfendorfer 2015). Data analyzed from the Everglades portion of the smalltooth sawfish range suggests that the population growth rate for that region may be around 5 percent per year (Carlson and Osborne 2012; Carlson et al. 2007). Intrinsic rates of growth (λ) for smalltooth sawfish have been estimated at 1.08-1.14 per year and 1.237-1.150 per year by Simpfendorfer (2000) and Carlson and Simpfendorfer (2015) respectively. Although this rate is very slow, any potential lethal interactions and probable nonlethal interactions with sturgeon sampling gear are not likely to occur at levels sufficient to reverse these trends. Chapman et al. (2011) found the remnant smalltooth sawfish population exhibits high genetic diversity (allelic richness, alleles per locus, heterozygosity) and will likely retain > 90 percent of its current genetic diversity over the next century. NMFS is currently funding several actions identified in the recovery plan for smalltooth sawfish including adult satellite tagging studies and monitoring take in commercial fisheries. Additionally, NMFS has developed safe handling guidelines for the species.

We expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on the smalltooth sawfish population trend. Similarly, we do not anticipate any long-term adverse effects on either individual fish or the population resulting from the capture and live release of smalltooth sawfish by sturgeon researchers. In summary, there is no indication that the anticipated small amount of smalltooth sawfish take resulting from sturgeon research activities poses a threat to the species recovery.

6.3.7 Sea Turtle Exposure and Response Analysis

Sea turtles found in the area of sturgeon research may be subjected to incidental capture and vessel interactions. The action areas of sturgeon research are typically in freshwater rivers or near the edge of the salt wedge of bays, so the likelihood of a turtle being present in these areas is slim. No sturgeon Permit Holder has reported the incidental capture or death of a sea turtle during directed sturgeon research in the Permits Division’s history. The capture techniques for sturgeon in freshwater areas are selective for the species. However, the use of otter trawls and similar equipment in marine areas may overlap with turtle ranges and the possibility exists that some incidental take will occur. Sea turtle life stages potentially affected range from post-hatchlings to adults. Post-hatchlings could be exposed to vessels but are too small to become entangled in sturgeon nets. Hence, the sea turtles likely to be most impacted are juvenile, subadult or adult animals.

Vessels in the marine areas could collide with turtles in the upper water column. Vessel strikes are a poorly-studied threat, but have the potential to be an important source of mortality to sea turtle populations (Work et al. 2010). All sea turtles must surface to breathe, and several species are known to bask at the surface for long periods. Although sea turtles can move rapidly, sea turtles apparently are not able to avoid vessels moving at more than 4 km/hour; most vessels move faster than this in open water (Hazel et al. 2007; Work et al. 2010). The presence of a sturgeon research vessel may disturb turtles resulting in their movement away from the vessel for a short time. Reactions may include a brief startle response, diving, submerging, or attempting to evade the vessel or personnel. Researchers are expected to be vigilant and proceed carefully to minimize risk of vessel strike and unnecessary disturbance when sea turtles may be in the area. Based on the anticipated responses, any disruptions are expected to be temporary in nature, with animals resuming normal behaviors shortly after the exposure. No reduction in fitness or overall health of individual sea turtles is anticipated due to the presence of research vessels in areas they occupy. There have been no reported sea turtle interactions by NMFS permitted sturgeon researchers in the past. Therefore, we determine that sturgeon research vessels represent an extremely small risk to ESA-listed sea turtle species.

Capture in sturgeon research gear can result in stress responses in sea turtles (Gregory 1994; Gregory and Schmid 2001; Hoopes et al. 1998; Jessop et al. 2003; Jessop et al. 2004; Thomson and Heithaus 2014). We also expect behavioral responses (attempts to break away via rapid swimming and biting) as well as physiological responses such as the release of stress hormones (Gregory et al. 1996; Gregory and Schmid 2001; Harms et al. 2003; Hoopes et al. 2000; Stabenau et al. 1991). Sea turtles forcibly submerged in any type of restrictive gear eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lungs (Lutcavage et al. 1997). Trawl studies have found that no mortality or serious injury occurred in tows of 50 minutes or less, but these increased rapidly to 70% after 90 minutes (Epperly et al. 2002; Henwood and Stuntz 1987). However, mortality has been observed in summer trawl tows as short as 15 minutes (Sasso and Epperly 2006). Metabolic changes that can impair a sea turtle's ability to function can occur within minutes of a forced submergence. Serious injury and mortality is likely due to acid-base imbalances resulting from accumulation of carbon dioxide and lactate in the bloodstream (Lutcavage et al. 1997); this imbalance can become apparent in captured, submerged sea turtles after a few minutes (Stabenau et al. 1991). Sea turtles entangled in nets exhibiting lethargy can die even with professional supportive care, possibly due to severe exertion resulting in muscle damage (Phillips et al. 2015).

Several mitigation measures are in place as part of the proposed action that should minimize the risk of adverse effects on sea turtles (see Appendix C for details). Since turtles may be susceptible to capture in pound nets, these gears will only be used in freshwater areas (<3.0 ppt) where sea turtles are not anticipated. In all boating and research activities within the study area, a close watch must be made for sea turtles present in order to avoid interaction or injury. Sturgeon research nets may not be deployed, or must be removed if previously deployed, upon sighting a sea turtle within a 100-foot radius of the netting area unless the turtle is seen on a path moving away. Netting may resume only after 30 minutes has elapsed since the sea turtle was last observed within the safety zone. In the unlikely event a sea turtle is incidentally captured or harmed, all permitted activities will be suspended until the Permits Division has granted approval to continue research. All sea turtles captured as part of the proposed action must be handled according to procedures specified in 50 CFR 223.206(d)(1)(i). Sturgeon researchers must use care when handling an incidentally captured sea turtle to minimize any possible injury; and appropriate resuscitation techniques must be used on any comatose turtle prior to returning it to the water. If the required mitigation techniques are adhered to, we expect that individual turtles would experience no more than short-term stresses during these types of incidental capture activities and that these stresses would dissipate within a short period.

6.3.8 Sea Turtle Risk Analysis

The North Atlantic DPS of green turtles has an estimated 30,058 to 64,396 female nesters in 2010 with an increasing population (Seminoff et al. 2015). The Northwest Atlantic DPS of loggerhead is estimated at 32,000 to 56,000 nesting females with populations in decline or not enough information to make a trend (NMFS 2001; TEWG 1998). Gallaway et al. (2013) estimated that nearly 189,000 female Kemp’s ridley sea turtles over the age of two years were alive in 2012 with an estimated total population of 248,307. Based on the number of hatchlings released in 2011 and 2012, and recognizing mortality, Gallaway et al. (2013) thought the total population may exceed one million turtles (NMFS and USFWS 2015). North Atlantic leatherbacks likely number 34,000 to 94,000 individuals, with females numbering 18,800 and the eastern Atlantic segment numbering 4,700 (TEWG 2007) and populations in the Caribbean and Atlantic Ocean are generally stable or increasing. Although no historical records of abundance are known, hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS 2007a). Worldwide, an estimated 22,004 to 29,035 hawksbills nest each year among 88 sites (NMFS and USFWS 2013) with an estimated 3,626 to 6,108 nesters in the Atlantic Ocean.

The Permits Division is requesting up to ten nonlethal captures of any sea turtle species per year, and up to three lethal takes of any species annually. Based on current population estimates, the proposed exposure represents a small portion of the population for each species of sea turtle, even if all 10 of the nonlethal take come from a single species or DPS. We expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on the sea turtle populations. Similarly, we do not anticipate any long-term adverse effects on either individual turtles or their populations resulting from the capture and live release of sea turtles by sturgeon researchers. In summary, there is no indication that the anticipated small amount of take of North Atlantic green, Northwest Atlantic loggerhead, hawksbill, Kemp’s ridley, or leatherback sea turtles resulting from sturgeon research activities poses a threat to the recovery of these species or DPSs.

6.4 Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). 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.

This section attempts to identify the likely changes present in the future and their impact on ESA-listed or proposed species and their critical habitats in the action area. This section is not meant to be a comprehensive socio-economic evaluation, but a brief outlook on future changes on the environment. Projections are based upon recognized organizations producing best-available information and reasonable rough-trend estimates of change stemming from these data. However, all changes are based upon projections that are subject to error and alteration by complex economic and social interactions. During this consultation, we searched for information on future state, tribal, local, and private (non-Federal) actions reasonably certain to occur in the action area. Based on this search, we expect the same threats currently facing the species as described in the *Environmental Baseline* (Section 5) will continue in the future. These include population growth, development, and land use changes, dams, dredging, LNG facilities, industrial and power generation plants, water quality and contaminants, non-native species, fisheries, ship strikes, scientific research, and global climate change. While some of these threats would involve a federal nexus and be subject to future ESA section 7 consultation, others will be entirely under the jurisdiction of state, tribal, or local authorities. An increase in these threats could result in increased effects to ESA-listed species, and for some (e.g., global climate change, LNG facilities, population growth, and land use changes) an increase in the future is considered reasonably certain to occur.

Probably one of the most certain future changes that ESA-listed species within the action area are likely to experience is that of global climate change. Even under predictions that consider stringent mitigation measures to reduce carbon dioxide emissions (IPCC Representative Concentration Pathway [RCP] 2.5), by the end of the 21st century (relative to 1986-2005) global temperatures are likely to rise between 0.3°C and 1.7°C, sea level is expected to rise between 0.26 and 0.55m, and increased ocean acidification is almost certain (IPCC 2014a). In less stringent RCPs, greater increases in global temperature, sea level, and ocean pH are predicted. Other climate changes such as increase drought and/or precipitation in some areas and changes in the frequency of extreme weather events are also likely to occur (IPCC 2014a). The impact of these changes on ESA-listed species are even more difficult to predict than the future climate scenarios themselves, but they will likely have direct, indirect, positive, and/or negative effects depending on the species and the particular climatic changes. Nonetheless, future impacts from global climate change on ESA-listed species are virtually certain to occur.

Given this threat of climate change and its relationship to carbon dioxide emissions, development and the use of renewable energy sources like wind, wave, and tidal energy are likely to increase within the near future. Many of these activities have a federal nexus and would likely undergo ESA section 7 consultation. Others may fall under state jurisdiction, such as Ocean Renewable Power Company’s current tidal turbine operations within the Bay of Fundy, and therefore may not undergo section 7 consultation. The impacts of these relatively new energy sources on ESA-listed species remains largely unknown. However, based on initial studies, potential negative impacts on ESA-listed species include altering migratory routes, changing species distributions, changing behavior due to electromagnetic fields, chemical and/or acoustic signals, and direct mortality (Boehlert and Gill 2010a; Copping et al. 2014; Dadswell 2006; Dadswell and Rulifson 1994; Dadswell et al. 1986)

As previously noted in the *Environmental Baseline*, LNG associated activities within the action area are also likely to increase, and thus so are impacts to ESA-listed species from these activities. LNG terminals in Georgia and Maryland are currently under construction and others have been proposed off New York and Florida (FERC website accessed January 26, 2017: https://www.ferc.gov/industries/gas/indus-act/lng.asp). Beyond these planned activities, there is evidence to suggest that natural gas from previously untapped shale deposits will become one of the most important energy developments in the United States within the past 50 years (American Chemical Council 2014). The effects of this increase in LNG related activities are expected to be similar to those described in the *Environmental Baseline*, but considerable uncertainty exists regarding the full impact they will have on ESA-listed species.

Finally, anthropogenic threats that ESA-listed species experiences due to population growth, development, and land use changes are also likely to increase. Between 2014 and 2060 the U.S. population is expected to increase from 319 million to 417 million (Colby and Ortman 2014) and of this population growth is expected to occur within the action area. Data over the past 10 years indicate a substantial population growth rate of 17-18 percent annually on the U.S. East Coast (U.S. Census Bureau, www.census.gov). With this population increase, the negative impacts of associated land use changes, pollution, contaminants, and water quality issues described for sturgeon in the *Environmental Baseline* are likely to increase, although the level of which remain unknown at this time. For turtles, future beachfront development, lighting, and beach erosion control projects are likely to reduce or degrade sea turtle nesting habitats and/or interfere with hatchling movement to the sea. These ongoing activities will likely continue along the Gulf and Atlantic coasts as coastal populations continue to grow in these regions.

For the remainder of activities and associated threats to sturgeon identified in the *Environmental Baseline*, and other unforeseen threats, the magnitude of increase and the significance of any anticipated effects remain unknown. Thus, this Opinion assumes effects in the future would be similar to those in the past and, therefore, are reflected in the anticipated trends described in the *Status of the Species* (Section 4) and *Environmental Baseline* sections. For sea turtles, stranding data indicate mortality can result from various natural causes, including cold stunning, as well as human activities, such as incidental capture in state fisheries, ingestion of or entanglement in debris, vessel strikes, and degradation of nesting habitat. While the cause of death of most sea turtles recovered by the stranding network is unknown, we anticipate the effects of these stressors to continue in the future.

6.5 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species due to implementation of the proposed action. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 6.4) to formulate the agency's biological opinion as to whether the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution. These assessments are made in full consideration of the status of the species (Section 4).

6.5.1 Atlantic and Shortnose Sturgeon

In this section, we first summarize the relevant components of the proposed Program designed to mitigate risks associated with the proposed action. We then summarize the status of sturgeon species, DPSs, and subpopulations in light of past, current and anticipated future threats as presented in the Environmental Baseline and Cumulative Effects sections of this opinion. Finally, we integrate the results of our Sturgeon Exposure and Response Analysis and Sturgeon Risk Analysis to evaluate the probable risk the proposed action poses to the survival and recovery of the five Atlantic sturgeon DPSs and shortnose sturgeon.

6.5.1.1 Sturgeon Research Permitting Program: Summary

As discussed throughout this opinion, there are several key components of the Permits Division's proposed Program that are designed to minimize adverse effects on individual sturgeon and to mitigate risks to the survival and recovery of sturgeon populations. While the proposed maximum mortality limits determine the upper limit on research allowed, the Permits Division would continually evaluate each permit application to ensure that the proposed research (including requested take levels) is necessary for the conservation and recovery of sturgeon populations. The Permits Division proposes to issue highly invasive procedures, which have a higher risk associated with adverse effects, with caution and conservatively regardless of the number that can be issued within the maximum mortality limits.

ESA regulations require that all research and enhancement permits issued by the Permits Division must meet specific regulatory issuance criteria. These include: (1) the permit will be used in a manner consistent with the ESA goal of listed-species conservation and will not be used to the disadvantage of species, (2) the research is bona fide and necessary for the survival and recovery of species, (3) a surrogate (non-listed) species cannot be used instead, (4) the permit holder has the necessary expertise, facilities, or other resources to achieve research objectives, and (5) the validity and need for the proposed research is reviewed by other researchers and species experts. These criteria are designed to reduce adverse effects and risk by decreasing the likelihood that ESA-listed species will be exposed to stressors from research activities that are either duplicative, extraneous or will not result in information (e.g., data, published papers) that can be used for the conservation of ESA-listed species. At present, there are still major information gaps and basic research needs for many Atlantic and shortnose sturgeon populations. However, as more information is collected and research objectives are met over time, the Permit Division may authorize lower levels of sturgeon research takes, particularly in well-studied river systems. Sturgeon researchers may then shift their research focus to smaller, less-studied ("unknown") river systems, which could provide valuable information for the conservation and recovery of sturgeon populations.

In addition to regulatory issuance criteria, all permit holders under this programmatic are required to follow general permit terms and conditions. These include: (1) reporting requirements that are necessary to track take (lethal and sublethal) and monitor the effects of authorized research activities on sturgeon populations, (2) notification and coordination requirements designed to maximize efficiency and minimize duplicative research efforts that could result in higher levels of exposure to stressors than absolutely necessary, and (3) requirements related to the qualifications, responsibilities, and designation of personnel designed to assure that mitigation measures are closely followed and all procedures are performed using the required standard protocols. Also included in all research and enhancement permits issued by the Permit Division are terms and conditions related to permit modification, suspension, and revocation. These assure that the Permit Division can take the appropriate measures a permit holder's actions result in increased risk to individual sturgeon (or other ESA-listed species) or to the populations they comprise, beyond what was authorized in the permit. In addition, the Permits Division can modify a research or enhancement permit if, based on new information, it determines that the previously authorized activities will unnecessarily expose individual sturgeon to stressors or will result in a greater risk to the survival and recovery of threatened and endangered species.

Another integral component of the Program for reducing risk and avoiding jeopardy or adverse modification over time is the proposed adaptive management approach. This is particularly important considering that the Program (and this opinion) does not have a sunset date. Based on historical data, over time the development of new and improved sturgeon research protocols, required as a condition of the permit, have greatly reduced adverse effects and mortalities resulting from research activities. The adaptive management approach allows the Permits Division to continually update and improve on mitigation measures designed specifically to reduce adverse effects on sturgeon as well as ESA-listed species taken incidentally as part of the proposed action.

Also part of the adaptive management approach, as new information is made available regarding sturgeon population health or risks from certain invasive procedures, the Permit Division can make program level or individual permit level changes, as necessary, to further reduce the risk to ESA-listed species or their critical habitat. The proposed Program is also specifically designed to incorporate future cumulative effects in their permitting process, as it allows them to adjust authorized take to account of changes in species' status that may result from currently unpredictable threats. On an annual basis, the Permits Division will evaluate the status of each river system population of sturgeon, and with it, possible changes in anthropogenic threats. If there are increases in the threats sturgeon face from ship strikes, fisheries, etc., the Permits Division could adjust their permitted research activities accordingly to minimize overall impacts to the species. Thus, despite our inability to accurately predict cumulative effects to ESA-listed species within the action area, by its very nature implementation of the proposed Program accounts for any such unforeseeable effects.

The adaptability and flexibility of the proposed Program is also viewed as a beneficial feature for addressing the potential impacts of climate change on ESA-listed species considered in this opinion. Environmental changes resulting from climate change may affect shortnose and Atlantic sturgeon a number of ways (e.g., shifting salt wedge, flooding and/or drought, elevated water temperatures, and decreased water quality). The proposed Program's adaptive management approach allows Permits Division to respond to any changes in the status, health or distribution of sturgeon populations due to climate change, and make the necessary and timely program-level or permit level adjustments to avoid jeopardy or adverse modification to ESA-listed species in the action area.

Continued close collaboration and an on-going dialogue between the Permits Division and the Interagency Cooperation Division will also be an important component of the proposed adaptive approach to managing the program. Annual program reports and periodic program evaluations (every 5-years or more often as needed) will allow NMFS OPR to evaluate if the assumptions made in effects analysis of this opinion are still valid. If new information indicates that a procedure has greater impacts than those analyzed in this opinion, the Permits Division will consult (either informally or formally) with the Interagency Cooperation Division and use the additional documentation to modify individual permits as needed.

6.5.1.2 Current Status and Threats: Summary

Atlantic and shortnose sturgeon populations within the action area have declined sharply over the past century. As discussed in the *Environmental Baseline* section, the major anthropogenic stressors that contributed to the sharp decline of sturgeon populations were commercial fisheries, habitat curtailment and alteration from dams and dredging, and degraded water quality. While sturgeon are still at risk from anthropogenic threats, some of the major threats that contributed to sharp population declines in the past have either been eliminated or reduced. Efforts made over the past few decades to reduce the impact of these threats have slowed the rate of decline for many sturgeon populations. Directed commercial fishing for Atlantic sturgeon, which decimated the population during the 20th century, was prohibited coast-wide by the late 1990's. Several dams within Atlantic and shortnose sturgeon historic ranges have been removed or naturally breached. Implementation of the CWA resulted in water quality improvements throughout the species' range, although many rivers and estuaries occupied by sturgeon are still not meeting their designated use water quality standards. The USEPA recently implemented regulations designed to reduce impact of impingement and entrainment of aquatic organisms in cooling water intakes systems (79 FR 48300-439 2015). As the rule is implemented, through individual ESA section 10(a)(1)(B) plant consultations with the USFWS and NMFS, it will include a number of provisions designed to mitigate, reduce and monitor the take of ESA-listed species. While fisheries bycatch, vessel strikes, and impingement and entrainment still represent sources of mortality, sturgeon mortalities resulting from these activities are expected to either remain at current levels, or possibly decrease with additional research efforts, conservation measures, and the continued implementation of existing environmental regulations. In addition, many activities that result in sturgeon take have already undergone formal section 7 consultation and are covered for take by an existing ITS; some of which would presumably need to reinitiate consultation with NMFS in the future to continue the activity.

Based on our *Cumulative Effects* analysis (Section 6.4), it is likely that some current threats to Atlantic and shortnose sturgeon will increase in the future. These include global climate change, LNG facilities, population growth, and land use changes. It is difficult to predict the magnitude of these threats in the future or their impact on sturgeon populations, particularly considering that the program has no sunset date. However, as discussed above, the proposed action takes into account future cumulative effects in the permitting process, as it allows for adjustments in authorized take levels to account for changes in the status of populations that may result from currently unpredictable threats.

The GOM DPS of Atlantic sturgeon is listed as threatened and includes six river systems. The Kennebec River is the primary spawning and nursery area for GOM Atlantic sturgeon. The removal of the Edwards Dam in 1999 resulted in 17 additional miles of historical spawning habitat accessible to Kennebec River Atlantic sturgeon and improved water quality. For purposes of the proposed Program, the Kennebec River was rated as health category "high" based on the following health index criteria: regular spawning; juveniles present and progressing through age classes; no major ongoing threats; two minor threats (water quality and impingement/entrainment); and a relatively large estimated effective population size.

The New York Bight DPS of Atlantic sturgeon is listed as endangered and includes seven river systems, only three of which are known spawning subpopulations: Delaware, Hudson River, with intermittent spawning in the Connecticut. Long-term surveys indicate that the Hudson River subpopulation has been stable and/or slightly increasing since 1995 in abundance (ASSRT 2007b). Some of the stressors to New York Bight DPS Atlantic sturgeon, while still present, have been reduced over the past few decades. Water quality in the Hudson has improved markedly since the 1980s and is no longer considered a major threat to this subpopulation (ASSRT 2007b). Similarly, restrictions on dredging in the upper portions of the Delaware have likely had beneficial impacts on Atlantic sturgeon spawning success. For purposes of the proposed Program, the Hudson and Delaware populations were both rated as health category "high" based on the following health index criteria: regular spawning; juveniles present and progressing through age classes; no major ongoing threats; a few minor threats including water quality and impingement/entrainment; and relatively large estimated effective population sizes.

The Chesapeake DPS of Atlantic sturgeon is listed as endangered and includes seven river systems, only two of which are known spawning subpopulations (James and York rivers). A recent study by Balazik and Musick (2015) indicates that two races of Atlantic sturgeon repeatedly spawn during two different times (spring and fall) and places in the James River, and possibly the groups have become genetically distinct from each other. For purposes of the proposed Program, the James subpopulation is rated as health category "medium" based on the following health index criteria: regular spawning; juveniles present; one major ongoing threat due to invasive species; two minor threats (impingement/entrainment, bycatch); and a relatively large estimated effective population size. The York subpopulation is rated as health category "low" primarily for having a negative (-3 percent) population trend. Given its low health rating and small population size, a very small maximum mortality limit (five-year average of 1.24) would be initially authorized in the York River system under the proposed action. The initial maximum mortality limit could change over time with changes in population health rating or population size.

The Carolina DPS of Atlantic sturgeon is listed as endangered and includes eight river systems, only one of which is a known spawning subpopulation (Roanoke River). Smith et al. (2015) identified fall spawning in the Roanoke River, suggesting there may be two populations (spring and fall) of spawners in this system. The Roanoke subpopulation is rated as health category "medium" for the proposed Program based on the following health index criteria: average adult survival rate (84%); regular spawning; juveniles present and progressing through age classes; one major ongoing threat (bycatch); one minor threat (water quality); and a relatively small estimated effective population size.

The South Atlantic DPS of Atlantic sturgeon is listed as endangered and includes ten river systems. Currently, this DPS supports six known spawning subpopulations: ACE Basin, Savannah, Ogeechee, Altamaha, Satilla, and St. Mary's. Farrae et al. (2017) found genetically distinct fall- and spring-spawned Atlantic sturgeon in the Edisto River (part of the ACE Basin), and genetic diversity of both groups was on the higher end of published population diversity values. The Savannah and Altamaha subpopulations are rated as health category "high" for the proposed Program based on the following health index criteria: average adult survival rate; regular spawning; juveniles present and progressing through age classes; and relatively large estimated effective population sizes. The ACE, Ogeechee, and Satilla subpopulations are rated as health category "medium" as these systems are somewhat smaller compared to the Altamaha and Savannah, and juvenile progression through age classes has not been confirmed in these systems.

There are no known major threats in any of the ten river populations within this DPS; several face minor threats, mainly water quality and bycatch.

Recent studies indicate that genetically distinct populations of spring and fall-run Atlantic sturgeon can exist within a given river system (Balazik and Musick 2015; Farrae et al. 2017). It has yet to be determined how widespread this dual spawning strategy is among sturgeon populations coast-wide. These initial findings suggest that at least some Atlantic sturgeon populations have a higher genetic diversity and may be more resilient to environmental perturbations than originally thought. In addition, Atlantic sturgeon adult population sizes, either based on empirical census data or derived from effective population size, could be underestimates if they do not account for the dual populations that may exist in some river systems.

For shortnose sturgeon, the largest adult subpopulations are found in the Northeastern rivers (i.e., Hudson, Delaware, Kennebec and St. John). Shortnose sturgeon subpopulations in southern rivers are considerably smaller by comparison with the largest in this region occurring in the Altamaha and Savannah Rivers. Population trend estimates are available for six shortnose sturgeon spawning stocks: St John, Kennebec, Hudson, and Satilla are all decreasing slightly (-1 percent); Delaware and Ogeechee are stable (0 percent). The SSSRT evaluated the extinction risk for three shortnose subpopulations (Hudson, Cooper, and Altamaha) and concluded that the estimated probability of extinction was zero for all three under the default assumptions, despite the long (100-year) horizon and the relatively high year-to-year variability in fertility and survival rates. Regular spawning is known to occur in 12 river systems. Major threats to shortnose sturgeon, defined as threats that if altered could lead to recovery, are currently identified for four river systems: dams in the Connecticut, Santee, and Cooper rivers, and water quality in the St. Mary’s River. The most prevalent minor threats to shortnose sturgeon are water quality (ten populations), bycatch (eight populations), and impingement/entrainment (six populations). Based on information from the status matrices developed for this proposed Program, a health category rating of “high” was assigned to six shortnose sturgeon river populations: Kennebecasis, Androscoggin, Connecticut, Delaware, Savannah, and Altamaha. A “medium” health category rating was assigned to seven shortnose sturgeon river populations: St. John, Kennebec, Merrimack, Hudson, Cape Fear, Cooper, and Ogeechee rivers. Only the Satilla River was assigned a “low” health rating, based primarily on a very low estimated adult population size (100) and a slight decreasing population trend (-1 percent).

6.5.1.3 Sturgeon Exposure, Response, and Risk Analyses: Summary

The proposed action would have both sublethal and lethal effects on Atlantic and shortnose sturgeon. Based on our sturgeon exposure and response analysis (Section 6.3.1), we determine that sub-lethal effects on Atlantic and shortnose sturgeon resulting from research activities authorized under the proposed action will be minimal, short-term, and are not likely to result in any reduced fitness or loss of fecundity to individual fish. Mortality of sturgeon will be limited in the proposed action by annual maximum mortality limits created at the species, river system, and life stage (i.e., early life stages, juvenile and adult/subadult) level. The sturgeon maximum mortality limits that are an integral part of the proposed action are designed to be protective of each subpopulation by setting an upper limit on the relative mortality rate within each river system. This approach is based on the conservative assumption that the loss of any particular subpopulation within the species or DPS could appreciably impact the survival and recovery of the DPS as a whole.

From our sturgeon risk analysis (Section 6..3.2), we determine that the authorized lethal take of early life stages as part of the proposed action is not likely to impact the survival or recovery of Atlantic and shortnose sturgeon river populations or the species/DPSs they comprise. For juvenile and adult/subadults, relative annual maximum mortality limits (as a proportion of the population) are determined by the health status of each river system, which are based on specific subpopulation attributes used to calculate a health index score. Maximum mortality limits are dynamic and can fluctuate from year to year based on new information regarding sturgeon population health and/or status and estimated population size. Based on our risk analysis (Section 6.3.2), we find that the proposed annual maximum mortality limits are well below target mortality rates for sturgeon population growth and recovery reported in the literature, and also well below estimated natural mortality rates. We also find that the proposed default mortality level for "unknown" systems is maximally conservative while still allowing for some research activities necessary for the recovery of Atlantic and shortnose sturgeon populations to continue. It is unlikely that use of a mortality buffer, which potentially doubles the relative mortality rate for a single year, would result in any significant long-term impacts on the survival or recovery of the population beyond the impact of the mortality limit without the buffer. Buffers would only be used if the mortality limit (without buffer) is inadvertently exceeded, and excess mortalities would need to be made up in future years to maintain the five-year average maximum mortality limit. In addition, several conservative assumptions made in establishing maximum mortality limits and accounting for delayed mortality from highly invasive procedures reduce the risk that the actual mortalities will exceed the relative annual maximum mortality limits unknowingly.

In the *Environmental Baseline* section of this opinion, we included the stressors associated with Atlantic and shortnose sturgeon research. However, all but one of the 17 current sturgeon research permits will expire within the next two years (13 expire in 2017; 3 expire in 2018) and would be replaced by permits issued under the proposed action. Although we cannot predict future research effort, from our exposure analysis we anticipate that future relative annual mortality rates under the proposed Program would be either similar to, or less than past research relative mortality rates due to the relative maximum mortality limits established by the proposed Program. Additionally, as has been demonstrated in the past, adverse effects (sublethal and lethal) to sturgeon and other ESA-listed species are expected to continue to decrease over time with new mitigation measures, research techniques, and technologies.

6.5.1.4 Overall Summary

Several components of the proposed action would mitigate adverse effects and assure that research activities permitted under the proposed Program are for the benefit of ESA-listed species and their critical habitat. These include: (1) regulatory issuance criteria designed to reduce adverse effects and risk resulting from research activities that are either duplicative, extraneous or will not result in information that can be used for species recovery, (2) general permit terms and conditions that provide the Permits Division with the information necessary to manage their Program, monitor take and the impacts on ESA-listed species, evaluate permit compliance, and modify or revoke permits as necessary to mitigate adverse effects to individuals and reduce the risk to the survival and recovery of ESA-listed populations, (3) species and habitat specific terms and conditions designed to mitigate and minimize the take (both directed and incidental) of ESA-listed species resulting from particular research activities, (4) proposed sturgeon maximum mortality limits that limit the lethal take (and by proxy sublethal take) that can be authorized within a particular river system, and (5) an adaptive management approach that gives the Permits Division the flexibility to make program level changes over time as new information regarding species status, threats, effects of research activities, improved protocols or technologies is made available.

Primary threats contributing to the sharp decline of sturgeon populations in the 20th century were commercial fisheries, habitat curtailment and alteration from dams and dredging. Efforts made over the past few decades to reduce the impact of these threats have slowed the rate of decline for many sturgeon populations. While fisheries bycatch, vessel strikes, and impingement and entrainment still represent sources of mortality, the impact of these activities on sturgeon populations are expected to either remain at current levels, or possibly decrease with additional research efforts, conservation measures, and the continued implementation of existing environmental regulations. In addition, the proposed action accounts for future cumulative effects by allowing for adjustments in authorized take levels based on changes in the status of populations that may result from currently unpredictable threats.

The sub-lethal effects on Atlantic and shortnose sturgeon resulting from research activities authorized under the proposed action will be minimal, short-term, and are not likely to result in any reduced fitness or loss of fecundity to individual fish. The proposed relative annual maximum mortality limits (as a proportion of population size) are not expected to reach levels that significantly affect the viability of Atlantic or shortnose sturgeon populations as listed under the ESA. In addition, the risk of actual mortality exceeding the prescribed maximum mortality limits is minimized due to conservative assumptions that would be used in creating the limits and monitoring mortalities. The proposed action is protective of each subpopulation (or spawning stock) within the species or DPS, as it sets upper limits on mortality at the river system level. This is premised on the conservative assumption that the loss of any individual subpopulation could appreciably increase the risk of extinction for the DPS or species as a whole. We anticipate that relative mortality rates authorized under the proposed Program would be either similar to, or less than relative mortality rates that resulted from past research activities due to the relative maximum mortality limits established by the proposed Program. Additionally, as has been demonstrated in the past, adverse effects (sublethal and lethal) to sturgeon and other ESA-listed species resulting from research activities are expected to continue to decrease over time with new mitigation measures, research techniques, and technologies.

In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the GOM DPS, New York Bight DPS, Chesapeake Bay DPS, Carolina DPS, or South Atlantic DPS of Atlantic sturgeon. We also determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the shortnose sturgeon.

6.5.2 Atlantic Salmon

Historically, Atlantic salmon occupied U.S. rivers throughout New England, with an estimated 300,000 to 500,000 adults returning annually (Fay et al. 2006). The GOM DPS Atlantic salmon was listed as endangered in response to population decline caused by many factors, including overexploitation, degradation of water quality and damming of rivers, all of which remain persistent threats (Fay et al. 2006). There are a number of actions underway or planned to help Atlantic salmon recover including hatchery supplementation, dam removal, protecting riparian habitat, reducing the impact of irrigation water withdrawals, and limiting the effects of recreational and commercial fishing. Even with current conservation efforts, returns of adult Atlantic salmon to the GOM DPS rivers remain extremely low, with an estimated extinction risk of nineteen to seventy-five percent in the next one hundred years (Fay et al. 2006). The total number of adult returns to U.S. rivers in 2015 was 921, the majority (eighty percent) of which were of hatchery origin. The fact that so few of the returning adults are naturally-reared is concerning to managers; the reliance on hatcheries can pose risks such as artificial selection, inbreeding depression and outbreeding depression (Fay et al. 2006). The DPS likely has a low resilience to additional perturbations (NOAA 2016).

The proposed research activities have mitigation measures specifically intended to reduce the probability of Atlantic salmon interactions and minimize the probability of mortality in the event of interactions. Based on our exposure and response analysis above (Section 6.3.3), We estimate that the proposed action will result in death of no more than two adult and ten other life stage (i.e., eggs, alevins, parr, smolts) GOM DPS Atlantic salmon annually. While the abundance trend information for Atlantic salmon is either stable or declining, based on our risk analysis (Section 6.3.4) we believe the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on that trend. Similarly, we do not anticipate any long-term adverse effects on either individual fish or the GOM DPS resulting from the capture and live release of Atlantic salmon by sturgeon researchers. In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the GOM DPS of Atlantic salmon.

6.5.3 Smalltooth Sawfish

The abundance of smalltooth sawfish has decreased dramatically over the past century and the U.S. population may be at less than five percent of historic levels based on the contraction of the species' range (Simpfendorfer 2002). The decline in the abundance of smalltooth sawfish has been attributed to fishing (primarily commercial and recreational bycatch), habitat modification (including changes to freshwater flow regimes due to climate change), and life history characteristics (i.e. slow-growing, relatively late-maturing, and long-lived species) (NMFS 2009; Simpfendorfer et al. 2011). These factors continue to threaten the smalltooth sawfish population. However, recent information indicates the smalltooth sawfish population is likely stable or increasing (Carlson and Osborne 2012; Carlson and Simpfendorfer 2015). The remnant population exhibits high genetic diversity and that inbreeding is rare (Chapman et al. 2011). The female population size is estimated at around 600 (Carlson and Simpfendorfer 2015). Chapman et al. (2011) estimate the effective genetic population size as 250-350 adults. The abundance of juveniles encountered in recent studies (Poulakis et al. 2014; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004) suggests that the smalltooth sawfish population remains reproductively viable.

Based on our exposure and response analysis above (Section 6.3.5), we estimate that the proposed action will result in the death of no more than two adult smalltooth sawfish annually. If smalltooth sawfish are not killed by being captured in gill nets or trawls (i.e., sublethal take), we expect that individual smalltooth sawfish would normally experience no more than short-term stresses as a result of handling and release. Based on our risk analysis (Section 3.6.6), we expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on the smalltooth sawfish population trend. Similarly, we do not anticipate any long-term adverse effects on either individual fish or the population resulting from the capture and live release of smalltooth sawfish by sturgeon researchers. In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the smalltooth sawfish.

6.5.4 Sea Turtles

Although sea turtles may be captured with sturgeon sampling gear, we expect such interactions to be to occur infrequently, with lethal interactions occurring very rarely. Below we discuss the potential impacts of the proposed action on each of the five ESA-listed sea turtle species that occur within the action area.

6.5.4.1 North Atlantic Green Sea Turtle

Green turtles in the North Atlantic DPS were at one time hunted for food, which was the principle cause of the population's decline. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS appears to be somewhat resilient to future perturbations. Nesting beach monitoring data and the Population Viability Analysis indicate that there is a 0.3 percent probability that this population will fall below the trend reference point (50 percent decline) at the end of 100 years, and a zero percent probability that this population will fall below the absolute abundance reference (100 females per year) at the end of 100 years (Seminoff et al. 2015). The North Atlantic DPS nester abundance is estimated at 167,424 females, and available data indicate an increasing trend in nesting (Seminoff et al. 2015).

The Permits Division is requesting up to ten nonlethal captures and up to three lethal takes of green sea turtles annually. Based on current population estimates, the proposed exposure represents an extremely small portion of the North Atlantic DPS green turtle population. We expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on this DPS. Similarly, we do not anticipate any long-term adverse effects on either individual turtles or the DPS resulting from the capture and live release of sea turtles by sturgeon researchers. Several mitigation measures are in place as part of the proposed action that should further minimize the risk of adverse effects on sea turtles. In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the North Atlantic DPS of green sea turtle.

6.5.4.2 Hawksbill Sea Turtle

Hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS 2007a). The species' resilience to additional perturbation is low. The greatest threats to hawksbill sea turtles are overharvesting of turtles and eggs, degradation of nesting habitat, and fisheries interactions. Nesting populations in the Atlantic (especially in Caribbean) are generally doing better than nesting populations in the Indo-Pacific regions. Surveys at eighty eight nesting sites worldwide indicate that 22,004 to 29,035 females nest annually (NMFS 2013a) with an estimated 3,626 to 6,108 nesters in the Atlantic Ocean.

The Permits Division is requesting up to ten nonlethal captures and up to three lethal takes of hawksbill sea turtles annually. Based on current population estimates, the proposed exposure represents a small portion of the hawksbill population. We expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on this species. Similarly, we do not anticipate any long-term adverse effects on either individual turtles or the species resulting from the capture and live release of sea turtles by sturgeon researchers. Several mitigation measures are in place as part of the proposed action that should further minimize the risk of adverse effects on sea turtles. In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the hawksbill sea turtle.

6.5.4.3 Kemp's Ridley Turtle

The Kemp's ridley was listed as endangered in response to a severe population decline, primarily the result of egg collection (NMFS and USFWS 2011) (NMFS and USWFS 2015). While fisheries bycatch remains a primary threat, the use of turtle excluder devices has mitigated take in commercial fishing gear. It is clear that the species is steadily increasing. Gallaway et al. (2013) estimated that nearly 189,000 female Kemp's ridley sea turtles over the age of two years were alive in 2012 with an estimated total population of 248,307. Based on the number of hatchlings released in 2011 and 2012, and recognizing mortality Gallaway et al. (2013) thought the total population may exceed one million turtles (NMFS and USWFS 2015). Genetic variability in Kemp's ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS and USFWS 2011). Despite some positive signs, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty (NMFS and USFWS 2011) (NMFS and USWFS 2015).

The Permits Division is requesting up to ten nonlethal captures and up to three lethal takes of Kemp's ridley sea turtles annually. Based on current population estimates, the proposed exposure represents a very small portion of the Kemp's ridley population. We expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on this species. Similarly, we do not anticipate any long-term adverse effects on either individual turtles or the species resulting from the capture and live release of sea turtles by sturgeon researchers. Several mitigation measures are in place as part of the proposed action that should further minimize the risk of adverse effects on sea turtles. In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the Kemp's ridley sea turtle.

6.5.4.4 Leatherback Sea Turtles

The leatherback sea turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades (NMFS 2007). The primary threats to leatherback sea turtles include fisheries bycatch, harvest of nesting females, and egg harvesting. Due to these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance (NMFS 2007). The species' resilience to additional perturbation is low (NMFS 2007). North Atlantic leatherbacks likely number 34,000 to 94,000 individuals, with females numbering 18,800 and the eastern Atlantic segment numbering 4,700 (TEWG 2007). Subpopulations in the Caribbean and Atlantic Ocean are generally stable or increasing. Analyses of mitochondrial DNA from leatherback turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999).

The Permits Division is requesting up to ten nonlethal captures and up to three lethal takes of hawksbill sea turtles annually. Based on current population estimates, the proposed exposure represents a very small portion of the hawksbill population. We expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on this species. Similarly, we do not anticipate any long-term adverse effects on either individual turtles or the species resulting from the capture and live release of sea turtles by sturgeon researchers. Several mitigation measures are in place as part of the proposed action that should further minimize the risk of adverse effects on sea turtles. In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the hawksbill sea turtle.

6.5.4.5 Northwest Atlantic Loggerhead Turtle

Due to declines in nest counts at index beaches in the United States and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS is at risk and likely to decline in the foreseeable future (Conant et al. 2009). The adult female population size of this DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS-SEFSC 2009). All four of the recovery units for the Northwest Atlantic DPS (Peninsular Florida, Northern, Northern Gulf of Mexico, and Greater Caribbean) all exhibit negative population growth rates (Conant et al. 2009).

The Permits Division is requesting up to ten nonlethal captures and up to three lethal takes of Northwest Atlantic DPS of loggerhead sea turtles annually. Based on current population estimates, the proposed exposure represents a very small portion of this DPS. We expect that the very small numbers of lethal interactions attributed to Atlantic and shortnose sturgeon research will not have any measurable effect on this DPS. Similarly, we do not anticipate any long-term adverse effects on either individual turtles or the species resulting from the capture and live release of sea turtles by sturgeon researchers. Several mitigation measures are in place as part of the proposed action that should further minimize the risk of adverse effects on sea turtles. In summary, we determine that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the Northwest Atlantic DPS of loggerhead sea turtle.

7 CONCLUSION

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the GOM DPS of Atlantic sturgeon or to destroy or adversely modify its proposed critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the New York Bight DPS of Atlantic sturgeon or to destroy or adversely modify its proposed critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Chesapeake Bay DPS of Atlantic sturgeon or to destroy or adversely modify its proposed critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Carolina DPS of Atlantic sturgeon or to destroy or adversely modify its proposed critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the South Atlantic DPS of Atlantic sturgeon or to destroy or adversely modify its proposed critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of shortnose sturgeon. No critical habitat has been designated or proposed for this species; therefore, none will be affected.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon or to destroy or adversely modify its designated critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the smalltooth sawfish or to destroy or adversely modify its designated critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the North Atlantic DPS of green sea turtle or to destroy or adversely modify its designated critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the hawksbill sea turtle or to destroy or adversely modify its designated critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Kemp's ridley sea turtle. No critical habitat has been designated or proposed for this species; therefore, none will be affected.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the leatherback sea turtle or to destroy or adversely modify its designated critical habitat.

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Northwest Atlantic loggerhead sea turtle or to destroy or adversely modify its designated critical habitat.

8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is further defined as an act which "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (NMFS 2016). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

8.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 CFR § 402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by the proposed action. The extent of take represents the "extent of land or marine area that may be affected by an action" and may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (51 FR 19953).

As discussed in Section 2.5.6 above, activities authorized as part of the proposed program may result in the incidental take of non-target ESA-listed species. Atlantic salmon, smalltooth sawfish, and sea turtles may be exposed to stressors resulting from incidental capture or entanglement in anchor gill nets, drift gill nets, trammel nets, trawls, trotlines, pound and trap nets, and beach seines. As part of the proposed action, any incidental take of non-target sturgeon species (or DPS) will be included with the directed take for that particular species (or DPS), and therefore will not be covered under this ITS.

Anticipated incidental take was determined based on our evaluation of the proposed action and information provided by the Permits Division in its BA. Incidental take estimates of the numbers of individuals by species and life stage, were developed by considering the following: (1) low level of historical incidental take that has occurred under sturgeon research permits, (2) mitigation measures in place to avoid future incidental take of non-target species, (3) population trends of each species (as available), and (4) projected changes in environmental conditions or sturgeon research focus that could potentially affect the spatial/temporal overlap between non-target species and sturgeon research activities. Anticipated annual incidental take (nonlethal and lethal) resulting from the proposed action is shown by species and life stage in Table 21. For the five ESA-listed sea turtle species in the action area, annual incidental take is expressed as a combined take limit due to the difficulty of predicting the number of takes by species in any given year.

8.2 Effects of the Take

In this Opinion, we have determined that the amount of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to any of the following species: green turtle North Atlantic DPS; hawksbill turtle; Kemp's ridley turtle; leatherback turtle; loggerhead turtle Northwest Atlantic DPS; Atlantic salmon GOM DPS; and smalltooth sawfish. Refer to Section 6.3 Exposure, Response and Risk Analysis for details regarding how we reached this determination.

Table 21. Anticipated annual incidental take (nonlethal and lethal) resulting from the proposed Program, by species and life stage.

Species	Life Stage(s)	Non-lethal Annual Number of Individuals	Lethal Annual Number of Individuals
Sea turtles combined: Green turtle North Atlantic DPS Hawksbill turtle Kemp's ridley turtle leatherback turtle Loggerhead turtle Northwest Atlantic DPS	Any	10	3
Atlantic Salmon – GOM DPS	Eggs, alevins, fry, parr, or smolt	10	10
Atlantic Salmon	Adult	5	2
Smalltooth sawfish	Any	5	2

8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and terms and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the ITS are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

The measures described below are nondiscretionary, and must be undertaken by the Permits Division so that they become binding conditions for the exemption in section 7(o)(2) to apply. NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

Reasonable and prudent measure #1: All section 10(a)(1)(A) sturgeon research permits authorized as part of the proposed action will include required terms and conditions (as described below) to minimize the impacts of incidental take on non-target ESA-listed species.

Reasonable and prudent measure #2: The Permits Division will monitor and evaluate the incidental take of ESA-listed species resulting from the proposed action and report the impacts of such incidental take to the Interagency Cooperation Division.

8.4 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the Permits Division must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above and outlines the mitigation, monitoring and reporting measures required by the section 7 regulations (50 CFR 402.14(i)). These terms and conditions are nondiscretionary. If the Permits Division fails to ensure compliance with these terms and conditions and their implementing reasonable and prudent measures, the protective coverage of section 7(o)(2) may lapse.

Terms and Conditions Required to Implement Reasonable and Prudent Measure # 1

The Permits Division will assure that all section 10(a)(1)(A) sturgeon research permits authorized as part of the proposed action will include the following required terms and conditions:

Sea Turtles

1. In the unlikely event a sea turtle is incidentally captured or harmed, all permitted activities would be suspended until the Permits Division Chief has granted approval to continue research.
2. Upon incidentally capturing a sea turtle, the permit holder or researchers acting on the permit holder's behalf must use care when handling a live turtle to minimize any possible injury.
3. Appropriate resuscitation techniques must be used on any comatose turtle prior to returning it to the water. All sea turtles must be handled according to procedures specified in 50 CFR 223.206(d)(1)(i), or as otherwise modified by NMFS in the future to reflect best management practices for sea turtle resuscitation.

4. In the event a captured sea turtle dies, or is severely injured, all permitted activities must cease and researchers must contact the Sea Turtle Stranding and Salvage Network regional coordinator as soon as possible, as well as the NMFS Permits Division.
5. Adverse interactions with sea turtles should be documented, including any pertinent detail (species, type of interaction, location, date, size, water and air temperature, any obvious patterns and photos if possible).
6. In all boating and research activities within the study area, a close watch must be made for sea turtles present in order to avoid interaction or injury.
7. Nets may not be deployed, or must be removed if previously deployed, upon sighting a sea turtle within a 100-foot radius of the netting area unless the turtle is seen on a path moving away. Netting may resume only after 30 minutes has elapsed since the sea turtle was last observed within the safety zone.
8. Pound nets or trapping gear may only be used in freshwater areas (< 3.0 ppt) where sea turtles or marine mammals are not anticipated.

Smalltooth Sawfish

9. Researchers operating in areas where sawfish are present are required to be trained by a member of the NMFS sawfish recovery team, or other NMFS approved trainer, to discuss proper handling procedures.
10. When attempting to handle and release an incidentally captured sawfish, researchers must use extreme caution, following procedures specified in the NMFS Sawfish Handling and Release Guidelines (Appendix F), or as otherwise modified by NMFS in the future to reflect best management practices for handling and releasing sawfish.
11. Researchers must keep the fish in the water at all times while cutting the net from the rostrum and body of the animal (no attempts should be made to disentangle the rostrum from the net).
12. Adverse interactions with sawfish should be documented, including any pertinent details of the interaction (type of gear type, what was done to handle and release the animals, location, date, size, water & air temp, and photos if possible).
13. In the event a smalltooth sawfish is incidentally captured or harmed by research activities, all activities are to be suspended until the Permits Division Chief has granted approval to continue research.

Atlantic Salmon

14. To be protective of Atlantic salmon on the Kennebec system, gill nets must not be set within 0.5 miles upstream or downstream of the confluences of the Kennebec River and Bond Brook, and 0.5 miles below Lockwood Dam. Nets must not be set within 0.5 miles upstream or downstream of the confluences of the Penobscot River and Cove Brook, Kenduskeag River, Ducktrap River, or Meadow Brook.
15. Researchers must avoid fishing in documented locations of the Penobscot River and Kennebec complex where Atlantic salmon have been encountered in the past (e.g., in

Kennebec: Sand Island @ < 43.914465,-69.727821>; Pine Island @ < 43.914465,-69.727821>; and Fort Halifax Park @ <44.54482,-69.627271> ; and in Penobscot: shallower, non-channel waters of Oak Point Cove @44.667005,- 68.822994; and Graham Station @44.821459,-68.708721)

16. In all GOM rivers with runs of Atlantic salmon (with exception in the Penobscot River), gillnets having > 6-inch mesh may only be fished in main channels of rivers and bays of the action area at depths greater than 20 feet or greater. Such nets may also be fished in areas characterized as ―mudflats, off main channels in waters less than 10 feet depth.
17. Only 12-inch mesh gillnets may be fished on the Penobscot River from the Waterworks at the site of the former Bangor Dam upstream to the form Veazie Dam site prior until October 1 of each permit year. Thereafter, until December 31 each year of the permit, 6-inch mesh or greater gillnets may be fished in the capture reach at anchored depths of less than 20-feet of water for one-half hour duration or less; and only when tagged Atlantic salmon are not present as determined by using available direct telemetry monitoring of Atlantic salmon.
18. The NMFS GARFO must be contacted prior to netting in the defined areas of GOM salmon run rivers to receive assurances Atlantic salmon passage is no longer anticipated, or is likely finished for the year based on the best available information.
19. Should an Atlantic salmon be taken incidentally during netting, researchers must suspend operations immediately and notify NMFS GARFO and the OPR Permits Division within 48 hours of any capture of an Atlantic salmon.
20. If an Atlantic salmon is incidentally captured, it must be handled minimally; and, if possible, released back into the water alive by cutting it free from the net while still being held in the water. Scale samples remaining on the net should be collected for genetic analysis and sent to the NMFS GARFO in labeled, sealed vials containing 95% ethanol.

Terms and Conditions Required to Implement Reasonable and Prudent Measure # 2

1. The Permits Division will include an incidental take section in their annual Program report (see Section 2.7 Reporting to the Interagency Cooperation Division). This section of the report will include the following:

    a) The number of individuals incidentally taken by species (or DPS), life stage, and type of take (i.e., nonlethal and lethal)

    b) A copy of each incident report, which includes the dates, locations, gear types, and any other relevant information that may assist in evaluating the impacts of incidental take on ESA-listed populations, DPSs, or species

c) Any permits modifications (e.g., changes in protocols, methods, or mitigation measures) made by the Permits Division in response to an incidental take occurrence in order to minimize the chance of additional incidental take by the permit holder in the future.

2. In addition to the annual reporting requirement, the Permits Division maintain a file with real-time updates on incidental take numbers (by species/DPS, life stage, and type of take) resulting from the proposed action. This file will be stored on a shared network drive accessible to the Interagency Cooperation Division.

9 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 CFR 402.02).

1. We recommend that the Permits Division continue to work collaboratively with the Interagency Cooperation Division to explore opportunities for developing and consulting on research programmatics for other ESA-listed species and/or taxa (e.g. sea turtles, cetaceans, and sawfish).

2. We recommend that the Permits Division continue to prioritize research that will assist with species recovery. In particular, the Permits Division should prioritize the authorization of sturgeon research that can be used to populate and/or update information in the proposed Program's status matrices that are used to establish sturgeon maximum mortality limits. Researchers should also be encouraged to conduct research on under-studied sturgeon populations and river systems for which there is currently little available information.

3. We recommend the Permits Division consider modifying the required reporting form for research permits to collect additional information that can further assist managers in protecting and conserving ESA-listed species. For example, the Permits Division could request researchers to provide population abundance estimates as they become available (e.g., unpublished data). Such information would not only better inform the Permits Division's future issuance of research permits, but could also be used in recovery plans and five-year species status reviews.

4. We recommend that the Permits Division work to establish protocols for data sharing among permitted researchers. While many researchers in the community collaborate, having a national standard for data sharing among researchers could improve the quality of research produced. Data sharing may also reduce adverse impacts to ESA-listed species and critical habitat by minimizing duplicative research efforts.

5. We recommend that the Permits Division continue to work collaboratively with the NMFS's Regional Offices to organize meetings and workshops to ensure that the results of all research programs or other studies on specific threatened or endangered species are communicated and coordinated among the different investigators and other interested parties. Such meetings may also be a venue to discuss the details outlined in our reporting and data sharing conservation recommendations (# 3 and 4 above). Meeting participants

should include regional species recovery coordinators, academic institutions, researchers, USFWS species experts, state agencies, and other stakeholders.

10 REINITIATION OF CONSULTATION

This concludes formal consultation for the OPR Permits and Conservation Division proposal to implement a program for the issuance of permits for research and enhancement activities on Atlantic and shortnose sturgeon. Since the proposed Program does not have a definitive sunset (or expiration) date, there is no pre-determined end date on this biological opinion. As discussed above (see *Integration and Synthesis* Section 6.5.1), the dynamic and adaptive elements of the Program (i.e., adaptive management approach) are critically important for reducing risk and avoiding jeopardy or adverse modification over time. The standard reinitiation triggers, which apply to all biological opinions, provide an additional safeguard against jeopardy or adverse modification over time. As 50 CFR 402.16 states, 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 incidental take is exceeded, (2) new information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the ESA-listed species or critical habitat that was not considered in this opinion, or (4) a new species is ESA-listed or critical habitat designated that may be affected by the action. Each of these standard reinitiation triggers is discussed below in the context of this consultation.

As described in Section 8 (above), the proposed action may result in some small level of incidental take of the following ESA-listed species or DPSs: GOM DPS Atlantic salmon, smalltooth sawfish, North Atlantic DPS green sea turtle, leatherback sea turtle, Kemp's ridley sea turtle, hawksbill sea turtle, and Northwest Atlantic DPS loggerhead sea turtle. Reinitiation of formal consultation is required if the incidental take of any of these species (or DPSs) exceeds the anticipated levels (trigger #1) specified in Table 21 (above).

Given the adaptive management approach that is built into the proposed action, we anticipate that reinitiation trigger #2 (above) will have limited application in the context of this consultation. That is, the proposed Program is structured such that new information regarding the effects of research activities on ESA-listed species and/or critical habitat can be incorporated into the Program without the need for reinitiation, assuming such changes are designed to be more protective, or at least equally protective, as the status quo. Some examples may include: (1) changes in general permit conditions to improve the monitoring of take or administration of the Program, (2) adding new mitigation measures to further minimize adverse effects (either directed or incidental) on ESA-listed species, (3) using new information regarding the status or health of sturgeon populations to update status matrices used to create sturgeon maximum mortality limits, or (4) applying updated information regarding delayed mortality risk from certain research procedures to the management of the maximum mortality limits.

Based on information obtained from permit holders or other sources, the Permits Division may determine that a sturgeon research maximum mortality limit (either five-year average or annual limit) for a particular species (or DPS), life stage and river system has been exceeded. While exceeding a maximum mortality limit may adversely affect ESA-listed species or critical habitat in a manner or to an extent not considered in this opinion, depending on the particular circumstances, such an incident may not automatically trigger reinitiation of formal consultation. Given the flexibility and adaptability built into the proposed Program, we anticipate that, in many instances, adverse effects resulting from exceeding a maximum mortality limit can be addressed through informal consultation and Program modifications not requiring reinitiation of formal consultation. Continued close collaboration and an on-going dialogue between the Permits Division and the Interagency Cooperation Division will be an important component of the proposed adaptive approach to managing the Program. As soon as it is determined that a maximum mortality limit has been exceeded, the Permits Division and the Interagency Cooperation Division consult informally to evaluate the impacts on the affected sturgeon population and species (or DPS), and work collaboratively on solutions for mitigating adverse effects. Reinitiation of formal consultation may be required if informal consultation does not result in Program changes that adequately address the adverse effects resulting from exceeding a maximum mortality limit.

Reinitiation trigger #3 (above) could be invoked if the Permits Division modifies the proposed action such that the adverse effects to ESA-listed species or designated critical habitat are greater than those effects considered in this opinion under the proposed Program. For example, any proposed increase in the relative (i.e., proportional) annual maximum mortality limits (Table 5) or the relative mortality buffers (Table 7), described in Section 2.5, could result in adverse effects to sturgeon populations beyond those considered in this opinion. Such a change to the Program, therefore, would trigger reinitiation of formal consultation.

Reinitiation of formal consultation is required if a new species is ESA-listed or critical habitat designated that may be affected by the action (trigger #4). As part of this consultation, we conferenced with the Permits Division on proposed critical habitat for the five DPSs of Atlantic sturgeon. We anticipate that reinitiation will not be required if critical habitat is designated for Atlantic sturgeon, unless final designated critical habitat is significantly different from the proposed critical habitat considered in this biological and conference opinion.

As discussed in the Description of the Proposed Action (Section 2), the Permits Division would work closely with the Interagency Cooperation Division throughout implementation of its Program. The two divisions will routinely (e.g., every 5 years or more frequently as needed) check-in on how the Program is functioning overall, and determine whether new information indicates that the Permits Division should request re-initiation of this consultation.

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Appendix A. Endangered Species Scientific Research and Enhancement Permit Application Instructions.

National Marine Fisheries Service

Endangered Species Scientific Research and Enhancement Permit Application

OMB No. 0648-0084
Expires: MM/DD/YYYY

Endangered Species Scientific Research and Enhancement Permit Application

TABLE OF CONTENTS

Introduction

What is this application for?

- This application is for requesting an Endangered Species Act (ESA) scientific research or enhancement permit to take[1], import, or export National Marine Fisheries Service (NMFS) protected species, including:
  - Sawfish (largetooth and smalltooth)
  - Sea turtles (in-water)
  - Sturgeon (Atlantic and shortnose)

What is this application not for?

- Research or enhancement activities on sea turtles on land or in rehabilitation
- Research or enhancement activities on marine mammals
- Only importing, exporting, or receiving protected species parts
- Commercial or educational photography
- Public display
- To apply for one of these permits, visit: http://www.nmfs.noaa.gov/pr/permits/types.html

When should I apply?

- At least 1 year before your project will begin

What is the process for getting a permit?

1. Follow these instructions and contact the Permits and Conservation Division at 301-427-8401 with any questions.
2. Submit your application via APPS (https://apps.nmfs.noaa.gov/).
   a. An assigned permit analyst will contact you and review the application.
3. Address any questions on the application. To facilitate processing, reference the application File No. in all correspondence.
   a. Once complete, we will publish a notice in the *Federal Register*, which starts a mandatory 30-day public comment period.
   b. Concurrently, we will send your application to subject matter experts in partner institutions and federal and state agencies for review.
   c. We will also request consultation under section 7 of the ESA to assess impacts to ESA-listed species. The ESA consultation can take up to 6 months.
4. Address any questions received during the comment period and consultation.
   a. We will then draft the permit and supporting documentation (including National Environmental Policy Act analyses and documentation of ESA issuance criteria), which will be reviewed by various NMFS offices including a legal review by General Counsel.

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

b. A Biological Opinion will be issued to determine if the activity will jeopardize the species or adversely modify critical habitat.
c. The Office Director will make a final decision.

Important information

- If you do not follow these instructions, your application will be withdrawn and you will be asked to resubmit a new application that includes the information required.

- If we request additional information and do not receive it within 60 days, we may withdraw your application.

- Your permit may only authorize what is in your application; therefore, it must be a stand-alone document that describes all proposed activities even when you reference previous permits or published literature.

- When a question does not apply (i.e., N/A), explain why.

- Your application should be free of grammatical errors and readable to a lay person.

- You are highly encouraged to contact us at 301-427-8401 with questions in advance of submitting your application.

How do I use APPS?

- Refer to Chapter 2 ("How to Use the System").

- When starting from your portfolio, click on the link of your file number under the File Number column to take you to the application.

- **Save your application every 20 minutes or you will lose information!**

- You do not have to complete an application in one session. Your application will remain in draft mode until you submit.

- An * means it is a required field.

- If you cut and paste from Word, special characters and formatting may be lost.

- Attachments cannot be larger than 10MB – contact us if you have larger files.

Questions?

- Contact the Permits and Conservation Division at 301-427-8401.

Application Instructions

Project Information

File Number

- This number is automatically generated and cannot be changed. To facilitate processing, reference this File No. in correspondence with our office.

****Project Title*** (up to 255 characters)

- Provide a concise title to include the activity, species (or taxa if multiple species), location, and purpose of the study. For example:
    - *Vessel surveys, sampling, and tagging sea turtles in the Gulf of Mexico to characterize population structure, forging ecology, and movement patterns.*

****Project Status***

- The project status (New or Renewal) is automatically selected based on your answers in the pre-application guide (PAG). Do not change this field.

Previous Federal or State Permit #

- If applicable, enter your most recent and closely related NMFS permit number. Otherwise leave blank. State permit numbers are not applicable.

****Permits Requested***

- One or more permit will be listed based on your answers in the PAG. If the options listed are incorrect, please call us at 301-427-8401 for assistance.

****Where Will the Activities Occur?***

- One or more general locations will be listed based on your answers in the PAG. If a location is incorrect, please call us at 301-427-8401 for assistance.

****Research Timeframe***

- Enter the desired start and end dates of the entire project in the following format: MM/DD/YYYY. The start date must not be prior to the date you submit the application and should be at least 1 year after the date you submit. The end date must be within five years of the start date because permits are generally valid for a five-year period. In some cases, a ten-year permit may be authorized.

****Sampling Season/Project Duration*** (up to 1,000 characters)

- Describe the annual field season(s) including the months and frequency of fieldwork (i.e., how many times per year and how frequently will you conduct your activities?). If this includes year-round research, indicate when activities are most likely to occur and how frequently.

Abstract (up to 2,000 characters)

- Federal regulations require the following information be published in the *Federal Register* Notice of Receipt that initiates a mandatory 30-day public comment period:
  - Purpose of the research or enhancement
  - Target and non-target species (common and scientific names)
  - Proposed take activities (e.g., capture, sampling, tagging), import, or export
  - Numbers of animals to be taken or imported/exported or number of animals from which specimens will be imported/exported, by species or taxa, annually
  - Specific geographic locations of take and locations from which animals or samples will be imported or to where they will be exported, if applicable
  - Requested duration of the permit

Project Description Page

Project Purpose: Hypothesis/Objectives and Justification (up to 64,000 characters)

- Discuss the **purpose** of your project including your hypotheses and/or objectives.

- Briefly **summarize published findings** related to your objectives. If you previously held or worked under a permit, use literature citations from that work to show how you previously met your objectives; or, use other published literature on the subject. Describe how this study is different from, builds upon, or duplicates past research.

- If proposing **novel procedures**, include a discussion on results from pilot studies or studies on other species, if available.

- Explain how you determined your **sample size/take numbers**. For example, did you base your numbers on previous encounter rates or abundance estimates for your study area? If appropriate for your study, include a power analysis or other sample size estimation to show whether the sample size is sufficient to provide statistically significant or otherwise robust results appropriate for your study.

- The information above should **support how your proposed research is *bona fide***, including how the results of your research are likely to published in a refereed scientific journal.

- Discuss why your project must involve ESA-listed species.

- Discuss how your project will, as applicable:
  - contribute to the objectives identified in the **species' recovery plan** or otherwise respond to recommendations of a scientific body charged with management of the species;

- contribute significantly to understanding the basic biology or ecology of the species; and
- contribute significantly to identifying, evaluating, or resolving conservation problems.

- For enhancement, describe how your work will enhance the survival and recovery of the species in the wild, or will enhance the propagation of the species for recovery purposes.

Project Description (up to 64,000 characters)

- **Your permit may only authorize what you describe in your application**.

- Provide a **brief overview** of a day on the water of the suite of activities you intend to perform on each animal during an encounter or capture event including where your work would happen, especially if different projects occur in different locations.
    - For sturgeon, provide location (i.e. river, bay, ocean basin) for each Take Action[2] you describe.

- **Methods**: Provide **clear descriptions of all methods** for each species, by Distinct Population Segment (DPS) where applicable, and the **number of animals by age class**[3] **and sex** you expect to take by each method/procedure **annually**.

- The **methods must match what is in the take table**.
    - There should be a narrative description for each Take Action, Observe/Collect Method[4], and Procedure[5] in the take table, and the take numbers and procedures in the narrative must match the table.
    - Reference take table lines in the narrative that correspond to the take actions and procedures, as needed.
    - If you have multiple projects, it is helpful to name them by project number or title and include project names in the Details column of the take table.

- Indicate the **number of times known individuals will be intentionally taken** in a year as driven by your objectives and study design (e.g., recapture for instrument retrieval or multiple biopsy samples per year). If recapturing animals,

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2 The Take Action is a generalized overview of how animals will be taken. You may only have one Take Action for each Take Row. Examples: Capture/handle release; Harass.

3 Define how age classes (e.g., early life stage fishes (ELS; includes eggs and larvae), post-hatchling turtles, juvenile, subadult, adult) are differentiated, by taxa or species.

4 The Observe/Collect Method is the method of observation (e.g., survey, vessel) or capture (e.g., net). Select only one observe/collect method per take table row.

5 Procedures are the individual activities you conduct on animals that have been captured/taken by a certain Take Action and Observe/Collect Method. Examples: sample, blood, fin clip, and swabs; external tagging.

indicate whether they will be immediately released without processing or fully or partially processed (i.e., what will be done to them on recapture).

- If some animals may be **unintentionally recaptured** in a year estimate how many and indicate whether they will be immediately released without processing or fully or partially processed.

- If some animals will only get a **subset of procedures**, list them on separate rows in the take table and make sure it is clear in the narrative. Explain how you decide which animals receive which procedures.

- If animals are being **captured under another legal source** (e.g., bycaught in commercial federal fishery) prior to research, identify the legal authority (e.g., ESA section 7 biological opinion with incidental take statement; another ESA section 10 permit) for the capture of these animals. Note: Annual take numbers requested for your research activities cannot exceed the number authorized for the original capture.

- Describe the **size** of animals for which you are requesting take.
  - For turtles, indicate the minimum size of the animals for the procedures you are requesting.
  - For sturgeon:
    - Include total length for each age class proposed.
    - Make sure you have indicated in the Objectives section above the purpose of working with each life stage/size.
    - In the details of the Take Table, define the size range of the targeted life stage.

- **Figures and photographs** are useful to illustrate your methods (e.g., tags and instrument attachments, nets and net deployment), especially for ESA consultations. You can attach them on the Supplemental Information page.

- Cite **references** for the methods where applicable, but do not substitute a literature citation for a complete description of the methods.

- Include a brief statement on the **purpose** of each procedure/how it relates to meeting your objectives.

- **Mitigation** measures that are standard protocols may be included in this methodology, or in Mitigation section below.

- See table below for examples of information to include when describing your methods.

Take action/ procedures	**Example details to include in methods**
Active acoustics	-Sound source (e.g., sidescan sonar, underwater speaker, acoustic deterrent device) -Source depth in water column -Frequency (bandwidth) -Maximum source level -Maximum received level -Distance to target and non-target animals -Signal duration and duty cycle -Duration of exposure -Ambient sound level, when known -Propagation loss model results, when available -Post playback monitoring
Administer drugs or other substances (e.g., stable isotopes, bone marking, anesthesia)	-Name of each drug/chemical and its purpose -Name of any drug reversal or emergency response drugs -Dosage of each -Delivery method and route (e.g., intramuscular, intravenous, subcutaneous, topical, immersion) -Location of administration on body -Duration of drug -Personnel that would administer drug (e.g., veterinarian or veterinary technician; state license requirements) -Post drug administration monitoring
Aerial and vessel surveys (manned)	-Type of survey craft and vessel -Type of survey (e.g., line transect, photogrammetry) -Number of surveys per year -Minimum and maximum altitude/approach distance -Air/ vessel speed -Protocols for breaking track to ID species -Duration spent with group or individual/day
Auditory brainstem response or evoked potential	-Type of measurement equipment (suction cup or needle electrodes) -Handling/restraint methods -Handling duration -Data collection and analysis method -Whether animal will be transported to a facility (complete the Transport Section in Take Table)
Captive experiments	-In addition to describing the procedures that will be performed on the animals, describe their care and maintenance, including a complete description of the facilities where they will be maintained. This includes but is not limited to: • dimensions of the pools or other holding facilities • number, sex, and age of animals by species to be held in each tank/enclosure • water supply, amount, and quality • diet, amount and type • sanitation practices. -Indicate the final disposition of animals after completion of experiments.

Take action/ procedures	Example details to include in methods
Capture and restraint	-Type of capture (e.g., hand or net (gill [drift or anchored], trawl, seine) and gear description -Deployment methods (e.g., boat approach and net set, tow or soak times) -Configuration, duration, and monitoring of net sets (how often net set is checked) -Numbers of animals captured at a time -Number of animals processed at a time -Anesthesia/sedation (see drug administration) -Dimensions and type of holding container -Number and roles of personnel (must be adequate to perform all activities without harming excess captured animals; else they must be released immediately) -Additional equipment or personnel necessary for capturing and handling excess numbers -Duration of restraint/holding from capture to release -Sea turtles: If handling sea turtles without a veterinarian present, identify an on-call veterinarian or nearby rehabilitation facility available for emergencies -Release
Export/import samples	-Type of sample (e.g., blood, muscle, gonad) -Country sending samples to, country of origin, or high seas -Designated port of entry/import or export -How sample/animal is taken in foreign country or on the high seas and legal take authority -Type of storage/shipping, including preservatives, etc. -Analysis -Re-import/export if samples remain after analysis
External instruments (a table is helpful for multiple tag types)	-Type of instrument -Location on body -Dimensions -Mass in air or water -Percentage of body mass -Minimum size of animal to receive each tag type -Maximum footprint/maximum number of tags/animal -Method of attachment (e.g., remote suction cup; restraint and epoxy/resin; monofilament line) -For remote deployment: number of attempts per animal/day, minimum approach distance and angle -Pain management if required (see Administration of Drugs) -Will it be coated with antifouling paint? -Duration of attachment procedure -Duration of instrument retention on animal -Release mechanism or recapture to remove -Type of data collection (e.g., archival requiring retrieval) -Type of data collection -How will you determine which animals receive which tags or more than one tag? -Post-tag monitoring

Take action/ procedures	Example details to include in methods
Internal instruments	-Type of instrument -Dimensions -Mass in air or water -Percentage of body mass -Size of animals (including minimum size) to receive an internal instrument -Location within body -Cleaning/sterile preparation -Insertion method (e.g., surgical implant, injection, stomach tube) and any applied coating on the tag (e.g., antibiotic) -Local anesthetic or anesthesia/sedation (see Administer drugs) if applicable -Personnel that would implant tag -Duration of insertion procedure -Duration of instrument retention -How stomach pills are voided -For sea turtles: include veterinary-approved protocol for stomach pills -Type of data collection
Intrusive sampling (e.g., blood, digital fecal extraction, laparoscopy, lavage, muscle, scute, skin, swabs); remote or under restraint	-Type of tissues -Size or volume of sample (diameter and depth or total volume) -Location on body -Number of samples per animal per capture event and per year, sampling intervals (e.g., for serial blood samples) -Sampling equipment description and disinfection -If restrained: cleansing site; left open or wound closure -If remote: collection method (e.g., pole sampling), minimum approach distance, number of attempts per animal -Minimum size of animal to receive each procedure -Pain management or sedation (drugs and dosages as above) -Whether animal will be transported to a facility for temporary holding (see Transport information in Take Table below) -Personnel that would perform intrusive procedures (see Personnel section below to include details on training and experience) -For sea turtles, include a veterinary-approved protocol for laparoscopy, tumor removal surgery, and bone biopsy -Sample storage and analysis

Marking (e.g., bone mark (OTC, fluorescent), flipper tag, Floy/dart tags, paing, PIT tag, shell etching)	-Type of mark
	-Location on body
	-Method of application
	-Disinfection procedures
	-Duration of mark
	-Dimensions of tag or mark
	-Size of animals to receive tags including minimum size
	-Total number and combination of tags or marks on each animal
	-For turtles:
	    -Local anesthetic for PIT tagging turtles <30 cm SCL
	    -Veterinary-approved protocol for PIT tagging turtles <15 cm SCL
	    -Type of paint (non-toxic only)

Take action/ procedures	Example details to include in methods
Non-intrusive sampling (e.g., behavioral observations, diagnostic imaging, collecting voided feces and urine, photogrammetry)	-Approach method -Sampling method (e.g., X-ray; genetic tissue from fin) -Minimum and maximum approach distance -Within sight of animals or not (e.g., from a blind)? -Frequency of observations/sampling/day -Duration of observations/sampling/day -Data or sample collection and analysis -Whether animal will be transported to a facility for temporary holding (see Transport information in Take Table below)
Unmanned Aircraft Systems (UAS) or **Underwater Remotely Operated Vehicles** (ROVs)	**For UAS**, same details for aerial surveys and also: -Type of UAS – fixed wing or vertical takeoff and landing -Payload components – what is the UAS carrying and for what purpose? -Size and mass of UAS -Will the UAS ever be beyond the line of sight? -Does the device have an auto-return feature should the device fail? -Ground control station description (what it is, where it will be located - on shore or on vessel, number of stations, and how close the station will be to animals) -Spotter roles (e.g., one spotter monitoring the UAS, another for monitoring the ground control station) -Battery life -Do you have the appropriate FAA permits/authorizations (including pilot licenses)? **For ROV**, same details as for vessel surveys and also: -Description and size of ROV -Whether it is tethered or wireless -Battery life -Deployment method, in relation to capture and release of animal, if applicable -Whether there will be a live video feed on the boat

Non-target species and conspecifics: Indicate the **estimated number and type of non-target species** that may be encountered in your study area annually, and whether and how they may be incidentally harassed, captured, or otherwise affected. This includes but is not limited to marine mammals and ESA-listed species such as fish, sea turtles, sea birds and plants.

- For ESA species designated by DPS, specify the DPSs that are likely to be encountered.
- Explain how you will avoid them or minimize impacts to them (e.g., not in area during time of study; would not approach closer than 100 meters; would halt operations until non-target species moved out of study area).
- If takes to non-target animals may occur, include these on separate rows in the Take Table to include incidental take (e.g., harassment or capture) of non-target conspecifics.

Project Supplemental Information

Attach a Supplemental Information File

- You may attach supplemental files here.

****Status of the Affected Species*** (up to 2,000 characters)

- As applicable, indicate the status of the species or stock as follows:
  - ESA - threatened or endangered; and
  - Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) - Appendix I, I, or III

  Species information is available at the following web sites:
  http://www.nmfs.noaa.gov/pr/species/
  http://www.fws.gov/
  http://www.cites.org/

****Lethal Take*** (up to 2,000 characters)

- If authorization for harm[6] or mortalities[7] (euthanasia/intentional[8] or accidental/unintentional) is proposed:
  - What activities could result in harm or mortality?

  - Explain why it's not feasible to use other methods that won't result in harm or mortality.
    - For euthanasia, indicate if it is for humane reasons (e.g., if working with compromised/comatose animals) or euthanasia for directed lethal take.
    - If a wild fish or turtle is requested for directed lethal take where it is required to be euthanized for scientific research purposes, explain how the research will directly benefit the species or fulfill a critically important research need with a conservation benefit.
    - Directed research requiring euthanasia of captive sturgeon is an optional disposition for such animals.

  - What is the maximum number of animals of each species/DPS and age class that could be harmed, unintentionally die, or be euthanized annually? Over the life of the permit?

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[6] Harm is defined an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering.

[7] Caused by the presence or actions of researchers including but not limited to harm or deaths resulting from infections related to intrusive procedures, sustained during capture and handling, or while attempting to escape capture.

[8] This includes unintentional euthanasia for humane reasons (e.g., if working with compromised/comatose animals). Only in rare instances may wild fish or turtles be sacrificed in directed research, unless there are clear, documented conservation benefits outweighing the loss.

- Justify the number of mortalities.

- How is euthanasia decided, conducted, and who conducts it?
  - For sea turtles, euthanasia must be determined and performed by an on-call veterinarian or rehabilitation facility.

- What are the protocols for necropsy and carcass disposal?

Anticipated Effects on Animals (up to 64,000 characters)

- Using the **best available science** (i.e., literature citations or other cited data sources) and your experience (e.g., personal communication), discuss how each take action and procedure listed in the take table (e.g., tissue sampling, marking, and instrumentation) will affect target and non-target animals (short-term and long-term).

- Include such things as typical **behavioral and physiological responses**, worst-case responses, % of animals that normally respond, how long it takes for animals to recover, and the time it takes wounds to heal.

- Also include an assessment of such things as:
  - condition of animals on recapture/resight
  - recovery from sedation and handling
  - post-release behavior (immediate and long-term)
  - habitat use for animals in resident populations (e.g., telemetry data, resightings)
  - healing from intrusive sampling
  - healing from intrusive tag deployments
  - tag retention
  - effects to nesting female sea turtles if working during the nesting period

- Condition of **bycaught non-target species**. Will they be released alive or is a certain percentage expected to be unintentionally harmed or killed?

- For **novel procedures or operating in more extreme environmental conditions**, discuss the most likely anticipated responses based on literature from studies on other species, if available.

- Summarize any **mortalities** that have occurred during the previous ten years of your permitted research using the same or similar techniques; include circumstances and cause of death.

- Discuss the anticipated **effects on the species or DPS**, especially if mortalities or reproductive effects are possible. On what is your determination based?

***Measures to Minimize Negative Effects** (up to 64,000 characters)

- **Mitigation and monitoring**: You may include mitigation and monitoring protocols here, in the Project Description section, or in the Anticipated Effects section. If included in another section, simply reference the section where the following information is found:

    - For each Take Action, Observe/Collect Method, and Procedure, describe your standard **mitigation to avoid or minimize the potential for adverse impacts** identified above.

    - Describe your short- and long-term **post-procedure monitoring** protocols.

    - If monitoring or mitigation is not feasible for specific procedures, species, situations, etc., explain why.

    - For sea turtles: if a proposed method (as indicated in the above methods table) or your institution requires a veterinary-approved protocol, attach the full protocol, any veterinary comments/recommendations, and the signed approval. This protocol may include an approved Institutional Animal Care and Use Committee (IACUC)[9] proposal to aid our assessment of impacts of your work under the ESA.

- **Research Coordination**: Describe how you will collaborate or coordinate with other researchers in your action area. Who are they? Explain **how** this will occur. For example, will it involve sharing vessels, samples, or data? Will it involve timing surveys to avoid disturbance or repeated captures of the same animals?

Attach a References File

- Attach a **bibliography** of references cited in this application. Referenced materials must be made available upon request, as needed for evaluation of the application, or preparation of any necessary ESA or NEPA analyses.

***Resources Needed to Accomplish Objectives** (up to 2,000 characters and attach files if necessary)

- Explain how your expertise, facilities, and resources are adequate to accomplish your proposed objectives and activities.

- Attach copies of any relevant formal research proposals, contracts, grant awards, or letters of agreement that would demonstrate financial or logistical resources.

- Indicate the status of any other international, federal, state, or local authorizations you have applied for, secured, or will apply for.

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[9] For **sea turtle** research: **NMFS researchers** are **required** to submit the NMFS IACUC-approved protocols and assurance letter.

Disposition of Tissue Samples (up to 2,000 characters)

- Indicate the disposition of any remaining samples after your project is complete.
    - State whether samples will be consumed in analysis, destroyed, or exported back to facility/researcher
    - If applicable, list the name and location of the person or institution that will store/curate samples. Indicate if you will retain legal custody of the archived samples or if you wish to permanently transfer the samples once your project is complete.

Public Availability of Product/Publications (up to 800 characters)

- Describe the end products of your proposed project and how they will be made available to the public.

Project Locations

- You will first describe where you plan to work. Then, for each location, you will use the Take Table to list the species you expect to encounter and the take procedures you will conduct in those locations.

- Add New Location: provide information about one (or more) study areas
    - General area (ocean basin)
    - State(s), as applicable.

- Enter Location Details, as applicable:
    - Waterbody: enter names of rivers, estuaries, bays, etc.
    - Latitude and longitude of your study area
    - River miles (Begin Mile and End Mile)
    - Limits of your study area (e.g., to the U.S. EEZ, to the edge of the continental shelf, to 50m depth)
    - Names of land masses where research will occur (e.g., islands, rookeries).

- Attach File: Attach a high quality map(s) with the correct scale that clearly shows the location of your proposed activity and any environmental aspects of interest. If possible, include a shapefile, Google Earth kmz/kml, or ASCII text file with lat/long data and the associated basic metadata with your electronic application submission.

Take Table

The take table represents the **estimated** number of animals you may take **annually** during your research.

The options that appear in the dropdown menus in the take table are based on the species group you indicated in the Pre-application Guide and the location that you have selected. If you are having difficulties, please first check that the previous fields were entered correctly.

Columns you will fill out in the take table:

1) **Select**: Leave this box blank unless you need to copy, move, or delete the line following the instructions above.

2) **Species**: Use the drop down list to select. Species are listed alphabetically by common name and/or category (e.g., dolphin, bottlenose). If the species you are looking for is not on the drop-down menu, double check your location (species are populated based on location). If you are still having problems, contact us at 301-427-8401.

3) **Listing Unit/Stock**: Select the applicable ESA listing unit/stock. Choose Range-wide if, for example, your location has multiple stocks of the same species and you cannot distinguish between them while in the field.

4) **Production/Origin**: Select from the drop-down list. Categories include Wild, Captive, Rehabilitation Facility (for marine mammals only), or All.

5) **Life Stage**: Select from the drop-down list. You may enter take information for more than one life stage (e.g., adult versus juvenile) on separate rows or select a combination of life stages for one take category. Include specified ages (including minimum mass/age of pups and calves) if they differ for each procedure in the Details column.

6) **Sex**: Select from the drop-down list. If your activity targets only one sex, indicate which. If it targets both and they can be targeted separately, enter separate rows for male and female; otherwise select Male and Female.

7) **Expected Take**: This represents a reasonable estimate of the maximum number of individuals you will take, import, or export, annually.

   For vessel surveys of sea turtles that do not involve capture, you will be required to count every animal you approach within 50 yards, regardless of whether a behavioral reaction has occurred. Count 1 take per animal observed per day when you know it is the same animal. If unable to identify the animal, count each turtle seen as a new take.

   For aerial surveys of sea turtles flown at an altitude lower than 700 ft[10], count 1 take per sea turtle observed per day, regardless of the number of passes over the same animal.

8) **Takes Per Animal**: Estimate the number of times the same individual will be taken annually, if known.

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10 We are looking for data to establish minimum thresholds for when take is likely to occur from vessel and aerial approaches.

9) **Take Action**: The "take action" is a generalized overview of how animals will be taken. If more than one action is proposed, you must enter the takes on separate rows.

10) **Observe/Collect Method**: Select the method of observation (e.g., survey, vessel) or collection/capture. Select only one observe/collect method per row. If various methods will be used, you must provide take information in separate rows for each observe method.

11) **Procedures**: Provide specific information on the research activities that will be conducted. A separate pop-up window will appear with a species-specific list of activities. Hold down the Control key to select all activities to be performed concurrently. Choose Other if your proposed activity is not listed. In the Details box (see below), briefly describe what the Other means.

12) **Transport**: If you chose transport as a Procedure, enter information about the transport.

    a) **Mode(s) of transportation**: Describe the mode of transportation. Include a description of the vehicle or other platform used to transport animals.

    b) **The name of the transportation company, if applicable, and the qualifications of the common carrier to transport live animals**: If a contractor or other entity will do the transportation, enter information in the box. Otherwise, click on N/A.

    c) **Maximum length of time from capture to arrival at destination**: How long will the animals be in transport?

    d) **Description of the container (e.g., cage, tank) used to hold the animal during transit**: Include the material of the container and its dimensions.

    e) **Any special care procedures (e.g., moisture, medicines) to be administered during transport**: How will the animals be cared for during transport?

    f) **A statement as to whether the animals will be accompanied by a veterinarian or some similarly qualified person**: If so, give the name, affiliation, contact information for each person.

    g) **Destination**: Use the drop down list to select the destination. If your destination is not on the list, click on the "New Facility" button to add it. If the animals will be taken to a laboratory or aquarium, provide details of the location. If the animals will be released in another waterbody, provide details of the location.

h) **How will the animals be contained at the destination facility?**: Describe the containment system for the animals, quarantine procedures, and effluent treatment.

i) **The final disposition of the animals**: Describe, for example, whether the animal will be released or retained in permanent captivity.

13) **Begin Date**: Populated with the Begin Date you entered on the Project Information page. You may change the date to coincide with a specific project time shorter than the overall duration of the project. You cannot enter a date that is earlier than your original Begin Date.

14) **End Date**: Populated with the End Date you entered on the Project Information page. You may change the date to coincide with a specific project time shorter than the overall duration of the project. You cannot enter a date that is later than the End Date you previously entered.

15) **Details**: Enter up to 255 characters in this text box to provide details on each take table row. This is especially useful for clarifying age class, takes, specific activities, or projects.

National Environmental Policy Act (NEPA) Considerations

In addition to providing information on effects to the target and non-target species in other sections of the application, provide information as requested below on potential environmental effects to determine if your activity may be categorically excluded from the requirement to prepare an environmental assessment or environmental impact statement under NEPA. If you believe any of the criteria are "not applicable" you must explain why.

1) If your activities will involve equipment (e.g., scientific instruments) or techniques that are new, untested, or otherwise have unknown or uncertain impacts on the biological or physical environment, please describe the equipment and techniques and provide any information about the use of these in the natural environment. In addition, please discuss the degree to which they are likely to be adopted by others for similar activities or applied more broadly.

2) Describe the physical characteristics of your project location, including:
   a. Whether you will be working in or near unique geographic areas including but not limited to Critical Habitat for endangered or threatened species, Essential Fish Habitat, National Marine Sanctuaries, Marine Protected Areas, State or National Parks, Wilderness Areas, Wildlife Refuges, Wild and Scenic Rivers, etc.

   b. Next, discuss how your activities could impact the physical environment in those locations, such as by direct alteration of substrate during use of anchoring vessels or buoys, erecting blinds or other structures, or ingress and egress of researchers, and measures you will take to minimize these impacts.

c. Is there potential to cause direct or indirect physical, chemical or biological alterations of the waters or substrate, including loss of, or injury to, benthic organisms (e.g., sea grass, corals), prey species and their habitat, and other ecosystem components? Could your actions reduce the quality and/or quantity of Essential Fish Habitat? If so, please provide additional details below:

- What is the degree of alteration (low, medium, high)?
- Approximately how much area (square footage) of habitat/substrate (e.g., seafloor, estuary or river bed) will be disturbed?

3) Briefly describe important scientific, cultural, or historic resources (e.g., archeological resources, animals used for subsistence, sites listed in or eligible for listing in the National Register of Historic Places) in your project area and discuss measures you will take to ensure your work does not cause loss or destruction of such resources.

4) Discuss whether your project involves activities known or suspected of introducing or spreading invasive species, intentionally or not, (e.g., transporting animals or tissues, discharging ballast water, use of boats/equipment at multiple sites). Describe measures you would take to prevent the possible introduction or spread of non-indigenous or invasive species, including plants, animals, microbes, or other biological agents.

Project Contacts

As the person entering the application, you will automatically be assigned the following roles: **Applicant/Permit Holder, Principal Investigator,** and **Primary Contact**. See Chapter 2 for directions on how to change who is assigned to these roles, and the table below.

Project Contact	Must be named in the permit application	Able to make changes to application, request changes to the permit, and submit reports; will receive automatic emails from APPS.	Description of qualifications required
Applicant/ Permit Holder	**X**	**X**	**X**
Applicant or Responsible Party*	**X**	**X**	
Principal Investigator	**X**	**X**	**X**
Primary Contact	**X**	**X**	
Co-Investigator	**X**		**X**

Project Contact	Must be named in the permit application	Able to make changes to application, request changes to the permit, and submit reports; will receive automatic emails from APPS.	Description of qualifications required
Authorized Recipients	**X**		
Research Assistants			

* The Applicant or Responsible Party may also be the PI or a CI if participating in the research; therefore, the description of qualifications is required if they are listed as the PI or a CI.

To prevent duplicate entries, **you MUST ALWAYS SEARCH the database for the person before entering a new contact.** To facilitate the search, start with only putting the last name in APPS search box.

A project must have a **Responsible Party** if the Applicant/Permit Holder is an organization, institution, or agency. The Responsible Party or Applicant/Permit Holder is an official who has the legal authority to bind the organization, institution, or agency and is ultimately responsible for the activities of any individual operating under the authority of the permit.

The **Principal Investigator** (PI) is the individual primarily responsible for the take, import, export, and any related activities conducted under the permit. There can only be one PI on a permit. The PI:

- must have qualifications, knowledge and experience relevant to the activities authorized by the permit
- must be on site during activities conducted under the permit unless a Co-Investigator is present to act in place of the PI
- may also be the Applicant/Permit Holder and Primary Contact.

Co-investigators (CIs) are individuals who are qualified and authorized to conduct or directly supervise activities conducted under a permit without the on-site supervision of the PI.

- You may add CIs to the application if the PI will not always be present during the permitted activities.
- CIs can also be added or removed once a permit has been issued.

Authorized Recipients (ARs) are persons or institutions authorized to receive samples for the purposes of analysis or curation related to the objectives of your permit. The PI and CIs may also be ARs. ARs should not be CIs if they are only performing the analysis and are not overseeing the study or publishing the results (i.e., they are only providing an analytical service).

Include a table listing the names of the PI and CIs, and the specific procedures they will oversee or conduct. **Attach the following table on the Supplemental Information page**.

Example Table Attachment: Personnel Roles

Name/Affiliation	Role	Activities
Researcher name, Affiliation, City, State	Principal Investigator, Co-investigator, or Authorized Recipient	Specific activities they will conduct under the permit and whether they are supervising
John Smith, Ph.D., University A, City, State	Principal Investigator and Authorized Recipient	Supervise and perform all activities under the permit
Jane Smith, Institution B, City, State	Co-investigator	All activities excluding anesthesia during captures and UAS
Jane Doe, Ph.D., Institution C, City, State	Co-investigator	Oversee and conduct captures, anesthesia, and surgical implantation of sonic tags
John Doe, Ph.D., University D, City, State	Co-investigator and Authorized Recipient	Collect skin biopsy samples and create cell lines
Laboratory E, City, State	Authorized Recipient	Receive subset of fin clip samples for DNA sequencing

Qualifications and Experience

Federal Regulations require that persons authorized as the PI or CIs have qualifications commensurate with their duties. In addition, the names of the PI and CIs are sent to the NOAA Office of Law Enforcement to determine if any violations of the ESA and other environmental laws have occurred.

The permit applicant is therefore required to submit the following information about the qualifications and experience of the PI and all CIs to demonstrate they have qualifications commensurate with their duties as stipulated in the Personnel Table. **A CV or resume must be up to date and contain all relevant information below**. If sufficient experience is not provided, additional information will be required and the personnel will not be authorized to conduct the proposed activities unless sufficient experience is demonstrated.

1) **Contact information -** All documentation submitted will be publicly available. **DO NOT include personal information** (e.g., social security number, date of birth, nationality, or home phone/ address-unless it is also the business phone/address).
   - Name (first middle last)
   - Business phone, e-mail, and mailing address

2) **Relevant education and training**
   - Degree, major, name of institution, year received

- Applicable certificates or licenses, year received
- Other relevant training or certification, year received

3) **Relevant experience**
   - Job title, affiliation/location, and dates of relevant experience
   - Detailed description of when and how the individual obtained training and experience in the methods they will be conducting and/or supervising as outlined in the Personnel Table. This should include objective metrics such as:
     - The specific level of training received and who trained them
     - The number of hours/months/years they have been performing the activities
     - Which and how many procedures they have performed successfully and on what species/age class (this is especially important for intrusive procedures such as blood and biopsy sampling, intrusive tagging, etc.)
     - Whether and to what extent they have performed the activities without supervision or supervised the proposed activities
     - What permits they have been PI or CI under and for what species and activities

4) **List of grants awarded demonstrating available resources relevant to the proposed activities or history of securing resources for similar work**

5) **Annotated publication history relevant to the activities being conducted under the permit**

Submit Application

See Chapter 2 for how to submit your application and check on its status.

Additional Information

Under section 10(a)(1)(A) of the ESA, persons may be authorized to take threatened and endangered species for purposes of scientific purposes or enhancing the survival or propagation of the species. Interested persons are required to submit an application in accordance with the ESA and the implementing regulations at 50 CFR part 222. These instructions for applying for a research or enhancement permit are drawn from, but do not substitute for, ESA regulations. These regulations are available at the following web site: http://www.gpo.gov/. ESA section 10(a)(1)(A) is available at: http://www.nmfs.noaa.gov/pr/pdfs/laws/esa_section10.pdf. Under NEPA, Federal agencies must assess the effects of federal actions on the environment. Under section 7 of the ESA, Federal agencies must ensure that the permitted activities will not jeopardize the continued existence of the species or result in adverse modification of critical habitat.

Paperwork Reduction Act Statement

The information requested in this application is required and is used to determine whether the activities described in the application are consistent with the purposes and policies of the Acts and their implementing regulations.

Public reporting burden for this collection of information is estimated to average 50 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Chief, Permits and Conservation Division, Office of Protected Resources, F/PR1, NOAA/National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910.

All permit documentation, including the application, permit and amendments, reports, inventory information, and any other associated documents are considered public information and as such, are subject to the Freedom of Information Act. Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.

OMB No. 0648-0084
Expires: MM/DD/YYYY

Appendix B. Application Review Checklist for Section 10(a)(1)(A) and NEPA Criteria

Protected Resources Permits and Conservation Division
Review of Protected Species Research or Enhancement Permit Application

File No. ___________________ Applicant: ______________________________

Species/location: ____

Criterion	Criterion met?(Y/N)	How?
Application Requirements		
Followed all instructions and used current OMB-approved version		
Application signed by appropriate person (individual applicant or Responsible Party verified)		
Application Requirements and Information for Section 7 Consultation		
Objectives are tied to recovery priorities (see issuance criteria below)		
Methods are described in sufficient detail to evaluate potential effects by species/age/sex/location including critical habitat		
Sample size is justified/ reasonably likely to occur		
Best available science is used to discuss possible adverse impacts and how they would be minimized or mitigated		
Proposed monitoring is appropriate to evaluate effects of research and recovery of animals post-handling or sampling		
Lethal take is justified		
Provisions for disposition of species at conclusion are described		
Have applied for, secured, or will apply for funding; and/or, have demonstrated record of securing funding		

Criterion	Criterion met?(Y/N)	How?
Issuance Criteria the Office Director Considers (50 CFR 222.308(c))		
The permit has been "applied for in good faith:" i.e., the applicant has demonstrated their intent to act consistent with the requirements of the ESA, regulations, and permit conditions; and their capability is consistent with what they purport to accomplish		
The proposed activity "will not operate to disadvantage of listed species:"		
Consistent with the purposes of the ESA (section 2), results would contribute to the objectives identified in the species' recovery plan or otherwise respond to recommendations of a scientific body charged with management of the species; contribute significantly to understanding the basic biology or ecology of the species; and contribute significantly to identifying, evaluating, or resolving conservation problems.		
Would further a bona fide and necessary or desirable scientific purpose; or enhance propagation or survival		
Personnel have adequate qualifications to carry out the proposed action and adequate facilities for captive care		
Proposed activities cannot be conducted using an alternative species or stock (not listed)		
Expert opinions have been considered and addressed		
Applicant has demonstrated compliance with IACUC requirements (required for NMFS turtle applicants only)		

Criterion	Criterion met?(Y/N)	How?
NEPA NAO 216-6A Extraordinary Circumstances – if not met, EA or EIS required		
Applicant has described methods and mitigation with sufficient detail for PR1 to evaluate potential effects on target and non-target species and the physical environment		
No potentially significant effect on human health or safety		
No potentially significant effect on a geographic area with unique environmental characteristics (e.g., park lands, prime farmlands, wetlands and floodplains, wild and scenic rivers, sole source aquifers, marine protected areas, national marine sanctuaries, national estuarine reserves, or national marine monuments)		
No potentially significant effect on species or habitats protected by the ESA, MMPA, MSA, or MBTA		
No potential generation, use, storage, transport, or disposal of significant quantities of hazardous or toxic substances, (e.g., materials used at laboratories or maintenance facilities		
No potentially significant effect on properties listed or eligible for listing on the National Register of Historic Places authorized by the NHPA, National Historic Landmarks designated by the Secretary of the Interior, or the National Monuments designated through the Antiquities Act; Federally recognized Tribal and Native Alaskan lands, cultural or natural resources, or religious or cultural sites		

Criterion	Criterion met?(Y/N)	How?
No disproportionately high or adverse effect on the health or the environment of minority or low-income communities		
No significant potential to introduce or spread invasive species (e.g., zebra mussels, cordgrass		
No potential violation of Federal, State, or local law or requirements imposed for protection of the environment		
No uncertain environmental effects or unique or unknown risks		

Analyst: ________________________ Date: ______________

Appendix C. ESA Section 10(a)(1)(A) Permit Template.

Permit No. XXXXX-0X
Expiration Date: month dd, yyyy
Reports Due: January 31st, annually

PERMIT TO TAKE PROTECTED SPECIES[1] FOR SCIENTIFIC AND/OR ENHANCEMENT PURPOSES

I. Authorization

This permit is issued to Name of Permit Holder, Affiliation, address, (hereinafter "Permit Holder"), [Responsible Party: Name], pursuant to the provisions of the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq*.); and the regulations governing the taking, importing, and exporting of endangered and threatened species (50 CFR Parts 222-226).

II. Abstract

The objective(s) of the permitted activity, as described in the application, is to [briefly summarize objectives].

III. Terms and Conditions

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

A. Duration of Permit

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

2. Researchers must immediately stop permitted activities and the Permit Holder must contact the Chief, NMFS Permits and Conservation Division (hereinafter "Permits Division") for written permission to resume
   a. If serious injury or mortality[2] of protected species occurs / reaches that specified in Table(s) X of Appendix 1.

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[1] "Protected species" include species listed as threatened or endangered under the ESA, and marine mammals.
[2] This permit allows for /does not allow for unintentional serious injury and mortality caused by the presence or actions of researchers up to the limit in Table X of Appendix 1. This includes, but is not limited to: deaths resulting from infections related to sampling procedures; and deaths or injuries sustained by animals during capture and handling, or while attempting to avoid researchers or escape capture. Note that for marine mammals, a serious injury is defined by regulation as any injury that will likely result in mortality.

b. If authorized take[3] is exceeded in any of the following ways:

i. More animals are taken than allowed in Table(s) X of Appendix 1.

ii. Animals are taken in a manner not authorized by this permit.

iii. Protected species other than those authorized by this permit are taken.

c. Following incident reporting requirements at Condition E.2.

d. At the discretion of the Division Chief, research may be suspended if annual reports are not submitted by their due dates. See Condition E.2 for reporting requirements.

3. The Permit Holder may continue to possess biological samples[4] acquired[5] under this permit after permit expiration without additional written authorization, provided the samples are maintained as specified in this permit.

B. <u>Number and Kind(s) of Protected Species, Location(s) and Manner of Taking</u>

1. The table(s) in Appendix 1 outline(s) the number of protected species authorized to be taken, and the locations, manner, and time period in which they may be taken.

2. Researchers working under this permit may collect images (e.g., photographs, video) in addition to the photo-identification or behavioral photo-documentation authorized in Appendix 1 as needed to document the permitted activities, provided the collection of such images does not result in takes.

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

4. The Chief, Permits Division may grant written approval for personnel performing activities not essential to achieving the research objectives (e.g., a documentary film crew) to be present, provided

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

[4] Biological samples include, but are not limited to: carcasses (whole or parts); and any tissues, fluids, or other specimens from live or dead protected species; except feces, urine, and spew collected from the water or ground.

[5] Authorized methods of sample acquisition are specified in Appendix 1.

a. The Permit Holder submits a request to the Permits Division specifying the purpose and nature of the activity, location, approximate dates, and number and roles of individuals for which permission is sought.

b. Non-essential personnel/activities will not influence the conduct of permitted activities or result in takes of protected species.

c. Persons authorized to accompany the Researchers for the purpose of such non-essential activities will not be allowed to participate in the permitted activities.

d. The Permit Holder and Researchers do not require compensation from the individuals in return for allowing them to accompany Researchers.

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

a. *Netting Practices with Gillnets*:

i. *In General*:

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

b. *Capture of Sturgeon*:

i. Gill nets and trammel nets may be fished for sturgeon in water temperatures between 0°C and 28°C and at dissolved oxygen concentrations of at least 4.5 mg/l (measured at the surface and the depth sampled); however, at temperatures less than 7ºC and above 27°C, research procedures must be limited to non-invasive procedures only (i.e., PIT and Floy tag, measure, weigh, photograph, and genetic tissue clip) (See Table 1 below).

ii. If the gear becomes snagged on substrate or debris, care must be given to loosen the tension on the net before attempting to free it.

iii. Location (GPS), temperature, dissolved oxygen (D.O.), gear used (e.g., mesh size and length), soak time, species captured, and any mortalities should be measured and recorded each time nets are set to ensure appropriate values according to the conditions below in Table 1 are followed. This data must be made available to NMFS in annual reports or upon request (See Appendix 3 for report format).

Table 1: Summary of environmental conditions regulating netting duration.

Water Temperature (ºC)	Minimum D.O. Level (mg/L)	Maximum Net Set Duration (hr)
0 < 15	4.5	14.06
0 < 15	4.5	4.07
15 < 20	4.5	2.08
20 < 25	4.5	1.08
27 < 28	4.5	0.58
> 28	N.A.	Cease Netting

iv. Drift Gill Netting:

(1) Drift gill nets may be used on the rising or falling tide or during slack water for 30 minutes to 2 hours, depending on the location and swiftness of the tide.

(2) Drift nets must be checked immediately if an obvious capture has been made or the gear has become snagged on substrate or debris.

(3) All drift net sets must be tended continuously due to the risk associated with gear entanglement, interaction with other protected species and/or the potential for loss of gear resulting in "ghost" nets (See Section 5.a.xi. below).

v. Trawling:

(1) A sonar scanning device & global positioning system should be used to monitor bottom characteristics prior to trawling to limit disturbance of substrate while trawling and also to prevent snagging of trawls on the bottom substrate.

(2) Trawls may be towed at a maximum speed of 2.5 knots and up to 20 minutes per trawl (bottom time) in marine water areas and up 10 minutes in fresh water areas.

vi. Pound Nets or other Trapping Nets: Pound or trapping gear are considered those *open to the surface*, having leaders not actively capturing or gilling fish; instead, spanning the depth of the water column, diverting fish away from shore and into the trap — or pound – located offshore.

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[6] Net-set duration of 14 hours (including unattended, overnight) is limited to fresh water (<2.0 ppt) ranges where unidentified populations or life stages may exist for presence or absence study objectives.

[7] Net sets must be continuously monitored and checked upon a net strike by targeted or non-targeted catch.

(1) Pound nets and trapping gear should be fished in accordance with state regulatory code.

(2) Pound nets or trapping gear may be used in freshwater areas (<3.0 ppt) where sea turtles or marine mammals are not anticipated.

(3) Pound nets may be used to retain sturgeon without stress for up to 24 hours as a "large holding pen."

vii. Larval Sampling using Egg Mats (artificial substrate), Seines, D-nets and Epibenthic sleds:

(1) Deployment of artificial substrates, d-nets, seines, or epibenthic sleds are authorized for lethally collecting sturgeon eggs and larvae up to the limit described in the Take Table(s) of Appendix 1.

(2) Eggs and larvae may be transported to the lab for species verification and preservation in 95% ETOH; the excess may be returned to the river at the site of collection, but are to be recorded as non-viable or lethally taken in annual reports.

(3) D-nets may be set for a maximum duration of three (3) hour intervals before checking.

(4) No more egg mats may be fished than necessary, and must be checked at least twice per week.

(5) Egg mats/D-nets may be fished at temperatures relevant to when spawning is anticipated by researchers, roughly corresponding to ranges of 10 ºC to 25 ºC in the spring and 18 ºC to 25 ºC in the fall.

(6) Egg mats/D-nets must be removed from rivers once spawning is complete or the authorized numbers of sturgeon eggs and/or larvae have been collected, whichever comes first.

(7) The epibenthic sled sampler should be towed against the prevailing current for 5 minutes averaging approximately 1.0 m/second speed through water.

(8) Researchers may also use divers and side scan sonar imaging to observe spawning (or other) activities.

(9) Larval Sampling using Beach Seines:

(a) When drawing the lead line of a beach seine close to shore, animals should be pooled in clearer waters with minimal turbidity.

(b) Larval samples may be preserved for later identification; however, others must be minimally handled and released within 30 minutes after pooled along the shore.

(c) Locations seined with beach seines must not be sampled more than once in a 24 hour period.

viii. "Entangled Nets":

(1) Should a net, trawl or trapping device become entangled on bottom substrate, debris, tree limbs, etc., efforts should be made to untangle it immediately to reduce further stress on animals.

(2) Should a net, trawl or trapping device become entangled and its entire portion cannot be immediately freed, its location should be clearly marked for later attempts to free it as soon as possible; and its location should also be reported to the Responsible Party and also the state regulatory authority.

(3) Should other abandoned "*ghost nets*" be located, researchers should attempt to remove the gear, if possible, and dispose of it properly.

c. *Specific Netting Conditions Protective of Atlantic Salmon in GOM Rivers*[8]

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

[8] https://www.google.com/maps/d/viewer?hl=en&oe=UTF8&vps=1&msa=0&ie=UTF8&jsv=255b&mid=10bjDztNfih2-9HCbUMVwdTHtLKY

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

iii. In all GOM rivers with runs of Atlantic salmon (with exception in the Penobscot River, noted in "iv." below), gillnets having ≥ 6" mesh may be fished in main channels of rivers and bays of the action area at depths greater than 20 feet or greater. Nets may also be fished in areas characterized as ―mudflats, off main channels in waters less than 10 feet depth.

iv. Only 12-inch mesh gillnets may be fished on the Penobscot River from the Waterworks at the site of the former Bangor Dam upstream to the form Veazie Dam site prior until October 1 of each permit year. Thereafter, until December 31 each year of the permit, 6-inch mesh or greater gillnets may be fished in in the capture reach at anchored depths of less than 20-feet of water for one-half hour duration or less; and only when tagged Atlantic salmon are not present as determined by using available direct telemetry monitoring of Atlantic salmon.

v. David Bean and/or Jeff Murphy (NMFS GARFO) must be contacted prior to netting in the defined areas of GOM salmon run rivers to receive assurances Atlantic salmon passage is no longer anticipated, or is likely finished for the year based on the best available information.

vi. Incidental take of Atlantic salmon is authorized in this permit by the Biological Opinion's Incidental Take Statement (See Appendix 1 Table 3).

vii. Should an Atlantic salmon be taken incidentally during netting, researchers must suspend operations immediately and notify David Bean at (207) 866-4172 (David.Bean@noaa.gov) and/or Jeff Murphy (NMFS GARFO); the Chief, Permits Division, Office of Protected Resources at (301) 427-8401 within 48 hours of any capture of an Atlantic salmon.

viii. If an Atlantic salmon is incidentally captured, it must be handled minimally; and, if possible, released back into the water alive by cutting it free from the net while still being held in the water. Scale samples remaining on the net should be collected for genetic analysis and sent to the contacts listed in "vii" above in a labeled, sealed vials containing 95% ethanol.

d. *Holding, and Handling Conditions for Sturgeon*:

i. Standardized length measurements for all captured sturgeon should recorded as referenced in Kahn and Mohead (2010), including fork length, total length, as well as the ratio of mouth width to interorbital width, differentiating shortnose sturgeon from Atlantic sturgeon.

ii. If possible, all sturgeon should be weighed, supporting them with a sling or net when moving. Handling should be minimized throughout weighing activities, using smooth rubber gloves to transfer them. They should be kept in water to the maximum extent possible to reduce stress.

iii. To accommodate larger catches, researchers must use secondary net pen(s), and also have adequate manpower and equipment available (i.e., extra crews and spare net pens); to avoid overcrowding or stressing fish. Individual animals must either be transferred to spare net pens to separate them, or else released.

iv. If holding fish onboard, they must be maintained in sufficiently sized and aerated live wells, allowing for total replacement of water volume every 15 minutes; or else they may be held in boat-side floating net pens and processed later. Backup oxygenation of on-board holding tanks with compressed oxygen is necessary when working with a larger number of fish to minimize stress.

v. Upon removing a non-responsive or overly stressed sturgeon from capture gear, researchers must allow the animal to recover in floating net pens or in well-aerated onboard live tanks. It must be shielded from direct sunlight. At the discretion of the researcher, however, the animal may be minimally examined and handled, and then released as soon as possible when recovered (Note: Researchers may PIT tag, measure, weigh, and genetic sample, and photograph an animal recovered from stress, but must not perform further research activities).

vii. The maximum holding time of an unstressed sturgeon after removal from capture gear until it is returned to the water, must not exceed two hours; however, at water temperatures > 27°C, holding time must be reduced to 30 minutes after removal from the capture gear. Fishing must never occur when water temperature is above 28°C, however (See exception authorized in Table 1 above).

viii. The total handling time included for onboard activities for individual sturgeon must not exceed 20 minutes (Note: This does not include recovery time from anesthesia or stressed condition).

ix. Sturgeon should be released only when showing signs of vigor and ability to swim away under its own power. Prior to release, while holding fish vertically and immersed in river water, sturgeon should be moved front to back to aid stimulation with freshwater passage over the gills. A spotter should watch the fish as it is released making sure it stays submerged and does not need additional recovery.

x. Because sturgeon are extremely sensitive to chlorine and other sanitizing solutions, if such agents are used between sampling, a thorough flushing of holding tanks would be required between sampling periods.

e. *Tagging Conditions for Sturgeon:*

i. Prior to placement of PIT tags, the entire dorsal surface of each fish must be scanned with a PIT tag reader to ensure detection of fish tagged in other studies. Previously tagged fish must not be retagged.

ii. The primary position that PIT tags can be injected is in the anterior dorsal fin musculature. However, in smaller sturgeon, to ensure tag retention and prevent harm or mortality, the PIT tag may also be inserted at the widest dorsal position. Other proven methods can be used by individual researchers, such as under the 4^{th} dorsal scute; however, the researcher would be required to inform all other researchers of such tagging position to ensure detection of all tags.

iii. Researchers may use PIT tags measuring 11.5 mm length x 2.1 mm diameter in juvenile sturgeon measuring at least 350 mm total length (TL). Alternately, PIT tags measuring 8.4 mm x 1.4 mm diameter may be used in sturgeon measuring between 250 and 350 mm TL.

iv. If considered vital to research objectives requiring public reporting of externally tagged animals, researchers may use numbered T-Bar or dart tags by inserting such tags forward and angled slightly downward through the dorsal fin pterygiophores and twisted to insure attachment. Sturgeon must measure at least 300 mm total length to be tagged with such tags to prevent harm.

v. Surgical implantation of internal telemetry tags may only be attempted by approved researchers designated in Section C (See Attachment 2: *How qualifications of researchers are evaluated*).

vi. Surgical implantation of internal telemetry tags may take place in sturgeon of the proper weight, size and condition. The total length of animals receiving an internal sonic tag should be greater than 300 mm; however, the total weight of all tags must not exceed 2% of a sturgeon's total body weight.

vii. Surgical implantation of internal telemetry tags in sturgeon may be attempted only when water temperature is less than 27 °C or greater than 7°C.

viii. Surgical instruments must be changed or disinfected and gloves changed between surgeries to avoid possible disease transmission.

ix. Surgical incisions are to be properly closed using proven sterile resorbtive or non-absorbable suture material. Either uninterrupted running or simple interrupted suturing techniques may be applied. Suturing material must be modified when negative results in healing related to suturing are documented on recaptured fish (See monitoring requirements in Section E 11).

x. Short-term, pop-off satellite tags are authorized for external tagging on the sturgeon's dorsal fin using a monofilament tether and without the use of anesthesia. (See Attachment 3: J. Sulikowski; pers comm. 2016).

xi. Researchers must document in annual and final reports any information on behavioral adaptation to telemetry tag by tracking individual fish, recording swimming behavior, periods between detections, and number of un-relocated individuals. Additionally, the healing rates of incisions on recaptured fish should be recorded (See Section

f. *Anesthesia (Using MS-222 or Electro-narcosis (EN)*):

i. Researchers performing anesthesia on sturgeon using MS-222 or EN, must have first received supervised training on the procedures on sturgeon or other close surrogate species. The Permit Holder or PI must report this training to the Permits Division prior to the activity (See Attachment 2: *How qualifications of researchers are evaluated*).

ii. Researchers may use MS-222 in solution for anesthetizing sturgeon at concentrations up to 150 mg/L; such solutions should be made fresh daily.

iii. Before anesthetizing animals with MS-222 researchers must saturate the solution with dissolved oxygen and buffer it to a neutral pH with sodium bicarbonate.

iv. Unused MS-222 solutions should be disposed of by using state-adopted procedures.

v. When using EN to induce anesthesia, NMFS recommends using low amperage direct, non-pulsed current, as described by Henyey *et al.* (2002).[9]

vi. Only non-stressed animals in excellent health and vigor may be anesthetized.

vii. To avoid injury to anesthetized sturgeon, researchers must use restraint in containers to prevent animals from jumping or falling out.

viii. When inducing anesthesia on sturgeon, researchers must observe fish at all times to establish when the proper level of anesthesia has been reached.

ix. Upon encountering a sudden reflex reaction during an invasive procedure on an anesthetized fish, the researcher must stop the procedure and evaluate the level of anesthesia before proceeding.

x. Researchers must observe sturgeon for proper recovery from anesthesia prior to release.

g. *Collection & Transfer of Biological Samples (e.g., genetic tissue samples)*[10]

i. Care must be used when collecting tissue samples. Instruments must be sanitized or changed and gloves must be changed between sampling each fish to avoid possible disease transmission or cross contamination of sample materials.

ii. Genetic tissue samples must be collected from all sturgeon by removing a small (1.0 cm^2) fin-clip from soft fin tissues using a pair of sharp scissors. NMFS recommends preserving samples in individually labeled and sealed vials containing 95% ethanol (See Attachment 1: *Instructions on air shipment precautions when using ethanol to preserve samples*).

iii. Researchers must transfer sturgeon genetic tissue samples and electronic records to the NOAA Tissue Sample Analyst and Archive within 12 months of collection (See Appendix 2a & 2b; See also Attachment 3: *Instructions on air shipment*

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9 Henyey, E., B. Kynard, and P. Zhuang. 2002. Use of electro-narcosis to immobilize juvenile lake and shortnose sturgeon for handling and the effects on their behavior. Journal of Applied Ichthyology 18: 502 – 504.

10 The NOAA Permits Division and Regional Offices of Protected Resources retain the right to transfer tissue samples to any Authorized Recipient for purposes of analyses; however, the data generated may not be published without consent of the Researcher or Responsible Party identified on the collecting permit.

precautions when using ethanol to preserve samples).).

iv. A Chain of Custody document (Appendix 2a) must be maintained for biological samples when transferring samples to other Authorized Recipients listed in Appendix 8 of this permit. Furthermore, a copy of this permit must accompany the samples during transport and remain on site during analysis or curation.

v. In general, the Permit Holder may retain duplicate samples not transferred to archives or Authorized Recipients; however, biological samples may not be transferred to others not listed in the permit without first obtaining prior written approval from NMFS. Any such transfer will be subject to such conditions as NMFS deems appropriate.

vi. The Permit Holder may continue to possess biological samples acquired under this permit after permit expiration without additional written authorization, provided the samples are maintained as specified in this permit. This also applies to samples transferred to other Authorized Recipients.

vii. Biological Samples must be maintained according to accepted curatorial standards and must be labeled with a unique identifier (e.g., alphanumeric code) that is connected to on-site records with information identifying the:

(1) legal authorization for original sample collection or import.
(2) species and, where known, age, sex, length/weight etc.,
(3) date of collection, acquisition, or import,
(4) type of sample (*e.g.*, blood, skin, bone), and
(5) location or origin collected (e.g., lat/long, river km) or imported.

viii. Biological samples may not be bought or sold.

ix. Researchers must document in annual and final reports any information on behavioral adaptation to telemetry tag by tracking individual fish, recording swimming behavior, periods between detections, and number of un-relocated individuals. Additionally, the healing rates of incisions on recaptured fish should be recorded.

h. *Endoscopic Examination (Borescope)*:

i. Borescopy for identifying sex/maturity is authorized on shortnose or Atlantic sturgeon (≥700 mm TL), specifically those not yet releasing eggs or sperm while handling.

ii. Prior to an individual researcher performing borescopy, s/he must first receive supervised training from a properly permitted individual using either wild or captive shortnose sturgeon, or another surrogate sturgeon species. The Responsible Party or PI must report individual training to NMFS prior to the activity, and then append a signed letter received from NMFS certifying the training (See Attachment 2: *How qualifications of researchers are evaluated*).

i. *Gastric Lavage for Diet Analysis*:

i. Gastric lavage for diet analysis must be performed as referenced in Kahn and Mohead (2010)[11]

ii. Prior to performing gastric lavage unassisted, a researcher must first have had supervised training from a properly permitted individual using either wild or captive Atlantic or shortnose sturgeon, or other close surrogate species. This training must be documented in Section C.1. of this permit (See Attachment 2: *How qualifications of researchers are evaluated*).

iii. Researchers should carry out gastric lavage using 1.90 mm diameter flexible tubing on sturgeon between 250 mm -350 mm (FL); 4.06 mm diameter flexible tubing may be used on sturgeon between 350 mm-1250 mm (FL); and 10.15 mm flexible tubing may be used on sturgeon over 1250 mm (FL).

iv. Researchers must attempt to monitor the effects resulting from gastric lavage on recaptured animals having

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[11] Kahn, J., and M. Mohead. 2010. A protocol for use of shortnose, Atlantic, Gulf, and green sturgeons. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

undergone the procedure (See Section E.c.3: *Monitoring requirements)*

v. Prior to performing gastric lavage, researchers must anesthetize sturgeon, allowing relaxation of the gut during penetration of the tubing to the proper positioning in the gut.

vi. While performing gastric lavage on Atlantic or shortnose sturgeon, researchers must irrigate the sturgeon's gills with ample water flow, insuring respiration.

j. <u>*Sturgeon Mortality or Serious Harm*</u>:

i. Incidental mortality or serious harm of sturgeon caused by research activity is authorized in this permit (See Section III.A.2.; E2, and Tables 1 & 2 of Appendix 1); however, each incidence must be reported to the Permits Division within two business days of the occurrence, and an incident report must be completed within 2 weeks (see Condition E.2). In addition, a genetic tissue sample of the animal must be forwarded to the NOAA tissue archive for genetic analysis within 30 days.

ii. NMFS requests that all sturgeon or body parts opportunistically found (or caused by research activities) be preserved—preferably iced or refrigerated—until sampling and disposal procedures are discussed with NMFS (See Appendix 4: *Sturgeon salvage form).*

k. <u>*Interaction with other Non-Target Species*</u>:[12] *6*

i. <u>Marine Mammal Interactions</u>:

(1) This permit does not authorize the capture, serious injury, or mortality of marine mammals.

(2) In the unlikely event a protected marine mammal is captured or harmed, all permitted activities would be suspended until the Permits Division has granted approval to continue research per Condition E.2.

(3) In the unlikely event a marine mammal is captured or harmed, the Greater Atlantic Region Marine Mammal and Sea Turtle Stranding and Entanglement Hotline must be contacted as soon as possible at (800) 281-

[12] The Permits Division does not anticipate impacts with sea turtles or marine mammals; however, these conditions are provided by turtle and marine mammal specialists within the Greater Atlantic Regional Fisheries Office in order to minimize interactions and/or impacts, as suggested.

9351, as well as the Chief, Permits Division and/or the permit analyst at 301- 427-8401.

(4) Researchers must submit a detailed report of any marine mammal bycatch within 48 hours to the Chief, Permits Division and/or the permit analyst at 301-427-8401; and to the Northeast Fisheries Science Center at 508-495-2358, and to the NMFS Greater Atlantic Regional Fisheries Office of Protected Resources at 978-282-8463 (see Section E xx for reporting marine mammal interactions).

(5) In all boating activities — including travel to acoustic receiver arrays — researchers are advised to keep a close watch for all marine mammals, proceeding at a safe enough speed to avoid harassment or adverse interaction. Additionally, researchers are advised to review the NMFS, Greater Atlantic Region Marine Mammal Approach and Viewing Guidelines located online at: http://www.greateratlantic.fisheries.noaa.gov/Protected/; and at http://www.nmfs.noaa.gov/pr/education/regional.htm.

(6) Netting activities must be closely attended and continuously monitored during deployment when netting in areas where marine mammals are likely to be encountered.

(7) Researchers must reduce speed or turn off boat engines or put them in neutral when approaching a marine mammal.

(8) If a marine mammal is observed within the vicinity (100-ft radius) of planned netting activity, it must be allowed to either leave or pass through the area safely before netting is initiated.

(9) Should a marine mammal enter a research area safety zone (100-ft radius) after nets are deployed, and remain within the vicinity, nets must be pulled. Netting may resume only after the animal is no longer within a radius safety zone, or 30 minutes has elapsed since the mammal was last observed within the safety zone.

ii. Sea Turtle Interaction:

(1) This permit does not authorize the capture, serious injury, or mortality of listed sea turtles.

(2) In the unlikely event a sea turtle is incidentally captured or harmed, all permitted activities would be suspended until the

Chief, Permits Division at 301-427-8401 has granted approval to continue research (see Conditions III A.2 and E.2).

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

(4) In the event a captured sea turtle dies, or is severely injured, all permitted activities must cease and researchers must contact the NOAA Greater Atlantic Marine Mammal and Sea Turtle Stranding and Entanglement Hotline as soon as possible at (800) 281-9351, as well as the Chief, Permits Division and/or the permit analyst at 301-427-8401 (see Conditions III A.2 and E.2).

(5) Adverse interactions with sea turtles should be documented, including any pertinent detail (species, type of interaction, location, date, size, water & air temp, any obvious patterns and photos if possible (See Section E. xx for documenting sea turtle interactions).

(6) In all boating and research activities within the study area, a close watch must be made for sea turtles present in order to avoid interaction or injury.

(7) Nets may not be deployed, or must be removed if previously deployed, upon sighting a sea turtle within a 100-foot radius of the netting area unless the turtle is seen on a path moving away. Netting may resume only after 30 minutes has elapsed since the sea turtle was last observed within the safety zone.

iii. Smalltooth Sawfish (*Pristis pectinata*):

(1) Incidental take of smalltooth sawfish is authorized in this permit by the Biological Opinion’s Incidental Take Statement (See Appendix 1 Table 3).

(2) Researchers operating in areas where sawfish are present are required to be trained by a member of the NMFS sawfish recovery team to discuss proper handling procedures, specifically:

(a) When attempting to handle and release an incidentally captured sawfish, Researchers must use extreme caution, using procedures specified in NMFS Sawfish Handling and Release Guidelines, found online at: http://www.nmfs.noaa.gov/sfa/hms/compliance/workshops/protected_species_workshop/sawfish_sturgeon/sawfish_release_guidelines_placard.pdf

(b) Researchers must keep the fish in the water at all times and cutting the net from the rostrum and body of the animal (no attempts should be made to disentangle the rostrum from the net).

(3) Adverse interactions with sawfish should be documented, including any pertinent details of the interaction (type of gear type, what was done to handle and release the animals, location, date, size, water & air temp, and photos if possible).

(4) In the event a smalltooth sawfish is incidentally captured or harmed by research activities, all activities are to be suspended until the Chief, Permits Division at 301-427-8401 has granted approval to continue research (see Conditions III A.2 and E.2). Also, contact Adam Brame in the Southeast Regional Office at (727) 209-5958.

iv. <u>North Atlantic Right Whale (*Eubalaena glacialis*)</u>:

(1) The Permit Holder must ensure research staff regularly conducts observations for right whales. Monitoring is required on all vessels and must be conducted by research staff with at sea large whale identification experience. In accordance with 50 CFR 224.103(c)(1), the Permit Holder must not get within 460 meters (500 yds) of a right whale. If a right whale is sighted within 500 yards of the vessel, immediate avoidance measures must be taken and researchers must immediately report the sighting and location data to either the U.S. Coast Guard or the appropriate NMFS Regional Administrator.

(2) Please report all right whale sightings to NMFS Sighting Advisory System:

- in any location to the U.S. Coast Guard on channel 16
- from VA to ME to (978) 585-8473
- from NC to FL to 904-237-4220

v. Manatees: See Appendix 7 for requirements provided by the U.S. Fish and Wildlife Service.

vi. Submerged Aquatic Vegetation (SAV; e.g., seagrass), Coral Communities, Hard and Live Bottom Habitat

(1) Researchers must take all practicable steps including the use of charts, GIS, sonar, fish finders, or other electronic devices to determine characteristics and suitability of bottom habitat prior to using gear to identify SAV, coral communities, and live/hard bottom habitats and avoid setting gear in such areas.

(2) No gear may be set, anchored on, or pulled across SAV, coral or hard/live bottom habitats.

(3) If research gear is lost, diligent efforts would be made to recover the lost gear to avoid further damage to benthic habitat and impacts related to "ghost fishing."

(4) *Seagrass*. Researchers must avoid conducting research over, on, or immediately adjacent to any seagrass species. If these species cannot be avoided, the following avoidance/minimization measures must be implemented:

a. To reduce the potential for sea grass damage, anchors must be set by hand when water visibility is acceptable. Anchors must be placed in unvegetated areas within seagrass meadows or areas having relatively sparse vegetation coverage. Anchor removal must be conducted in a manner that would avoid the dragging of anchors and anchor chains.

b. Researchers must take great care to avoid damaging any sea grass species and if the potential for anchor or net drag is evident researchers must suspend research activities immediately.

c. Researchers must be careful not to tread or trample on seagrass and coral reef habitat.

vii. Fisheries Bycatch (non-listed, commercial or non-listed, non-commercial fish species)

(1) Attempts should be made to release alive all incidentally captured species (e.g., fishes) as soon as possible.

viii. *Aquatic Nuisance Species*:

(1) To prevent potential spread of aquatic nuisance species

identified in the watershed, all equipment assigned to the research must not be reassigned to other watersheds until gear and equipment used is sanitized, rinsed, and dried.

6. <u>Transfer of Sturgeon Biological Samples</u>

   a. Samples may be sent to the Authorized Recipients listed in Appendix 2 provided that

      i. The analysis or curation is related to the research objectives of this permit.

      ii. A copy of this permit accompanies the samples during transport and remains on site during analysis or curation.

   b. Samples remain in the legal custody of the Permit Holder while in the possession of Authorized Recipients.

   c. The transfer of biological samples to anyone other than the Authorized Recipients in Appendix 2 requires written approval from the Chief, Permits Division.

   d. Samples cannot be bought or sold.

C. <u>Qualifications, Responsibilities, and Designation of Personnel</u>

1. At the discretion of the Permit Holder, the following Researchers may participate in the conduct of the permitted activities in accordance with their qualifications and the limitations specified herein:

   a. Principal Investigator – [name]

   b. Co-Investigator(s) –See Appendix 2 for list of names and corresponding activities.

   c. Research Assistants – personnel identified by the Permit Holder or Principal Investigator and qualified to act pursuant to Conditions C.2, C.3, and C.4 of this permit.

2. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities. The roles and responsibilities of personnel operating under this permit are as follows:

   a. The Permit Holder is ultimately responsible for activities of individuals operating under the authority of this permit. Where the Permit Holder is an institution/facility, the Responsible Party is the person at the institution/facility who is responsible for the supervision of the Principal Investigator.

b. The Principal Investigator (PI) is the individual primarily responsible for the taking, import, export and related activities conducted under the permit. The PI must be on site during activities conducted under this permit unless a Co-Investigator named in Condition C.1 is present to act in place of the PI.

c. Co-Investigators (CIs) are individuals who are qualified to conduct activities authorized by the permit, for the objectives described in the application, without the on-site supervision of the PI. CIs assume the role and responsibility of the PI in the PI's absence.

d. Research Assistants (RAs) are individuals who work under the direct and on-site supervision of the PI or a CI. RAs cannot conduct permitted activities in the absence of the PI or a CI.

3. Personnel involved in permitted activities must be reasonable in number and essential to conduct of the permitted activities. Essential personnel are limited to

   a. individuals who perform a function directly supportive of and necessary to the permitted activity (including operation of vessels or aircraft essential to conduct of the activity),

   b. individuals included as backup for those personnel essential to the conduct of the permitted activity, and

   c. individuals included for training purposes.

4. Persons who require state or Federal licenses or authorizations (e.g., veterinarians, pilots – including UAS operators) to conduct activities under the permit must be duly licensed/authorized and follow all applicable requirements when undertaking such activities.

5. Permitted activities may be conducted aboard vessels or aircraft, or in cooperation with individuals or organizations, engaged in commercial activities, provided the commercial activities are not conducted simultaneously with the permitted activities, except as specifically provided for in an Incidental Take Statement or Incidental Take Permit for the specific commercial activity.

6. The Permit Holder cannot require or receive direct or indirect compensation from a person approved to act as PI, CI, or RA under this permit in return for requesting such approval from the Permits Division.

7. The Permit Holder may add CIs by submitting a request to the Chief, Permits Division that includes a description of the individual's qualifications to conduct and oversee the activities authorized under this permit. If a CI will only be

responsible for a subset of permitted activities, the request must also specify the activities for which they would provide oversight.

7. For NMFS Science Centers Only: The Permit Holder or PI may designate additional CIs without prior approval from the Chief, Permits Division provided

   a. A copy of the letter designating the individual and specifying their duties under the permit is forwarded to the Permits Division by facsimile or email on the day of designation.

   b. The copy of the letter is accompanied by a summary of the individual's qualifications to conduct and supervise the permitted activities.

   c. The Permit Holder acknowledges that the designation is subject to review and revocation by the Chief, Permits Division.

8. Where the Permit Holder is an institution/facility, the Responsible Party may request a change of PI by submitting a request to the Chief, Permits Division that includes a description of the individual's qualifications to conduct and oversee the activities authorized under this permit.

9. Submit requests to add CIs or change the PI by one of the following:

   a. the online system at https://apps.nmfs.noaa.gov;
   b. an email attachment to the permit analyst for this permit; or
   c. a hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Room 13705, Silver Spring, MD 20910; phone (301)427-8401; fax (301)713-0376.

D. <u>Possession of Permit</u>

1. This permit cannot be transferred or assigned to any other person.

2. The Permit Holder and persons operating under the authority of this permit must possess a copy of this permit when

   a. Engaged in a permitted activity.

   b. A protected species is in transit incidental to a permitted activity.

   c. A protected species taken or imported under the permit is in the possession of such persons.

3. A duplicate copy of this permit must accompany or be attached to the container, package, enclosure, or other means of containment in which a protected species or protected species part is placed for purposes of storage, transit, supervision or care.

E. Reports

1. The Permit Holder must submit incident and annual reports containing the information and in the format specified by the Permits Division.

    a. Reports must be submitted to the Permits Division by one of the following:

        i. the online system at https://apps.nmfs.noaa.gov;

        ii. an email attachment to the permit analyst for this permit; or

        iii. a hard copy mailed or faxed to the Chief, Permits Division.

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

2. Incident reports: must be submitted within two weeks of a serious injury or any mortality, or exceeding authorized takes, as specified in Condition A.2 and B.x.

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

    b. If the total number of mortalities is reached or takes have been exceeded:

        i. in addition to the written report, the Permit Holder must contact the Permits Division by phone (301-427-8401) as soon as possible, but no later than within two business days of the incident.

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

3. Annual reports describing activities conducted during the previous permit calendar year (January to December) must

    a. be submitted by January 31st of the following year each year for which the permit is valid, and

    b. include a tabular accounting of takes and a narrative description of activities and effects.

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

reports, conference abstracts, papers, or publications resulting from permitted research must be submitted the Permits Division.

5. Specimens or body parts of dead sturgeon (found opportunistically or resulting from research activities), should be individually preserved — preferably on ice or refrigeration — until sampling and/or disposal procedures are discussed with NMFS. The sturgeon should be documented by completing the sturgeon salvage form (See Appendix 4).

6. Reporting of Monitored Activities: To ensure monitoring of certain authorized activities described below, researchers must meet with the Permitting Division annually to review research activities. During this meeting researchers must provide the following:

a. A report of all research effort conducted, including soak times, nets used (e.g., 3, 6, & 12 inch), temperature and D.O. at the time of each set, species of fish captured, and any mortalities (include conclusions on cause(s) of mortality and potential appropriate mitigations);

b. A field report documenting the transfer of individual genetic tissue samples to the NOAA Genetic Tissue Archive located at Kearneysville, West Virginia. This includes *A Biological Sample Certification, Identification and Chain of Custody Form* that must accompany shipments of genetic tissue samples within 12 months of collection (See Appendix 2a & 2b)

c. A report of the effects resulting from specified invasive methods (e.g., internal tagging, gastric lavage, and other procedures requiring chemical anesthesia with MS-222) must be made each year, including:
    i. Detailed records (including photographic evidence) on all recaptured animals having undergone a previous invasive procedure. Specifically, this report should document the weight, length, condition, health, tag retention, and surgical healing rate from any invasive procedures.
    ii. Documentation of any information on the behavioral adaptation to telemetry tags obtained by tracking individual fish, recording swimming behavior, recording periods between detections from the time of tagging, and documenting the number of un-relocated individuals.

F. Notification and Coordination

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

   a. Notification must include the

      i. locations of the intended field study and/or survey routes;

      ii. estimated dates of activities; and

      iii. number and roles of participants (for example: PI, CI, veterinarian, boat driver, safety diver, animal restrainer, Research Assistant "in training").

   b. Notification must be sent to the following Assistant Regional Administrator(s) for Protected Resources as applicable to the location of your activity:

      For activities in NC, SC, GA, FL, AL, MS, LA, TX, PR, and USVI:
      Southeast Region, NMFS, 263 13th Ave South, St. Petersburg, FL 33701; phone (727)824-5312; fax (727)824-5309
      Email (*preferred*): nmfs.ser.research.notification@noaa.gov; and

      For activities in ME, VT, NH, MA, NY, CT, NJ, DE, RI, MD, and VA:
      Greater Atlantic Region, NMFS, 55 Great Republic Drive, Gloucester, MA 01930; phone (978)281-9328; fax (978)281-9394
      Email (*preferred*): NMFS.GAR.permit.notification@noaa.gov

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

G. Observers and Inspections

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

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

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

H. Modification, Suspension, and Revocation

1. Permits are subject to suspension, revocation, modification, and denial in accordance with the provisions of subpart D [Permit Sanctions and Denials] of 15 CFR part 904.

2. The Director, NMFS Office of Protected Resources may modify, suspend, or revoke this permit in whole or in part

   a. in order to make the permit consistent with a change made after the date of permit issuance with respect to applicable regulations prescribed under section 4 of the ESA;

   b. in a case in which a violation of the terms and conditions of the permit is found;

   c. in response to a written request[13] from the Permit Holder;

   d. if NMFS determines that the application or other information pertaining to the permitted activities (including, but not limited to, reports pursuant to Section E of this permit and information provided to NOAA personnel pursuant to Section G of this permit) includes false information; and

   e. if NMFS determines that the authorized activities will operate to the disadvantage of threatened or endangered species or are otherwise no longer consistent with the purposes and policy in Section 2 of the ESA.

3. Issuance of this permit does not guarantee or imply that NMFS will issue or approve subsequent permits or modifications for the same or similar activities requested by the Permit Holder, including those of a continuing nature.

I. Penalties and Permit Sanctions

1. A person who violates a provision of this permit, the Marine Mammal Protection Act (MMPA), ESA, or the regulations at 50 CFR 222-226 is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the MMPA, ESA, and 15 CFR part 904.

[13] The Permit Holder may request changes to the permit related to: the objectives or purposes of the permitted activities; the species or number of animals taken; and the location, time, or manner of taking or importing protected species. Such requests must be submitted in writing to the Permits Division in the format specified in the application instructions.

2. The NMFS Office of Protected Resources shall be the sole arbiter of whether a given activity is within the scope and bounds of the authorization granted in this permit.

    a. The Permit Holder must contact the Permits Division for verification before conducting the activity if they are unsure whether an activity is within the scope of the permit.

    b. Failure to verify, where the NMFS Office of Protected Resources subsequently determines that an activity was outside the scope of the permit, may be used as evidence of a violation of the permit, the MMPA, the ESA, and applicable regulations in any enforcement actions.

J. Acceptance of Permit

1. In signing this permit, the Permit Holder

    a. agrees to abide by all terms and conditions set forth in the permit, all restrictions and relevant regulations under 50 CFR Parts 222-226, and all restrictions and requirements under the MMPA, and the ESA;

    b. acknowledges that the authority to conduct certain activities specified in the permit is conditional and subject to authorization by the Office Director; and

    c. acknowledges that this permit does not relieve the Permit Holder of the responsibility to obtain any other permits, or comply with any other Federal, State, local, or international laws or regulations.

______________________________ ________________
Donna S. Wieting Date Issued
Director, Office of Protected Resources
National Marine Fisheries Service

______________________________ ________________
[name of Permit Holder or Responsible Party] Date Effective
[permit holder's/RP's title and institution]
Permit Holder /or/ Responsible Party

Appendix D. Permits Division Annual Report Form for Section 10(a)(1)(A) Permit Holders

Protected Species Permit
Annual Report Form

We highly recommend you submit your report through the online system at https://apps.nmfs.noaa.gov.

If you do not submit your report online, please fill out this form and return

- by email attachment to the permit analyst for this permit; or
- by hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Suite 13705, Silver Spring, MD 20910; phone (301)427-8401; fax (301)713-0376.

Permit Number: **Date Prepared**:

Permit Holder's Name:

Reporting Period: (please check one)

☐ Annual #1 [date to date]
☐ Annual #2 [date to date]
☐ Annual #3 [date to date]
☐ Annual #4 [date to date]
☐ Annual #5 [date to date]
☐ Annual #6 [date to date]
☐ Annual #7 [date to date]
☐ Annual #8 [date to date]
☐ Annual #9 [date to date]
☐ Annual #10 [date to date]

Contact Name: **Contact Email**:

Contact Phone Number:

(Contact = person submitting report)

Part I: Take Table. Enter the actual number of animals taken[1] during this reporting period. Take tables from permits are inserted here with a column to be filled for "Actual number of animals taken." Contact your permit analyst for a copy of the permit take table.

If you conducted activities or took protected species for which you were not authorized, you must enter these takes on separate lines of the table. Explain what happened in Part II below.

Part II: **Narrative.** Review your permit before filling out this form to ensure you address reporting requirements specific to your research. Provide complete answers. If a question is not applicable, explain why.

1. How did target animals react to different research activities? Non-target animals? How often did you see these reactions (rate/percentage of times, etc.)? Summarize how target and non-target animals reacted to the procedures, the proportion of animals that had those reactions, and whether any unusual behavioral reactions were noted. See Section E of your permit for specific information needed.

2. Describe problems encountered during this reporting period and steps proposed or taken to resolve them. Examples include equipment failure, weather delays, safety issues and unanticipated effects to habitats or other species.

3. Did serious injuries or mortalities occur or did you take a protected species you were not permitted to take? If so, and you already submitted an incident report, please briefly describe the event here and refer to the incident report. If such an incident occurred and you have not yet reported it, provide a full description of the incident (e.g., how did the take occur; gross necropsy and histopathology findings or other information to confirm cause of death or extent of injuries) and steps that were or will be taken to reduce the possibility of it happening again.

4. What efforts did you make to conduct post-research monitoring? What did you find? Specifically, we are interested in data on:

- condition of animals on recapture
- healing from intrusive sampling
- healing from intrusive tag deployments (surgical tag implants requiring sutures, limpet and implant tagging sites, medial ridge and pygal tag sites)
- tag retention
- recovery from sedation and handling and post-release behavior
- repopulating rookeries/haul outs after flushing.

5. What efforts did you make to coordinate with the applicable NMFS Regional Office(s) and collaborate with other researchers? How did the collaborations occur (for example, timing of field work, sharing vessels, sharing data)?

6. What progress did you make toward meeting your objectives this year? Include full citations of any reports, publications, and presentations from this reporting period. Electronic copies must be made available upon request.

10th year Report - Summary of Your Research – In addition to the questions above, answer the following:

7. Did you meet your objectives? What did you learn?

8. If you did not meet your objectives, explain why. For example, if you did not tag or mark as many animals as needed to meet your sample size, explain why and how that impacted your ability to meet your objectives.

9. For ESA-listed species: Explain how your activities benefitted the species or promoted recovery or conservation of the target species. How did your research contribute to fulfilling the research needs or objectives in the Recovery or Conservation Plan (as applicable)? Explain.

10. Did you identify any additional or improved mitigation measures?

Feedback (optional)

We appreciate any feedback on APPS and your permit. For example, did you have any problems using APPS? Were any permit conditions difficult to comply with or unclear? Were your permitted take numbers appropriate?

Appendix E. Current Atlantic Sturgeon and Shortnose Sturgeon Research and Enhancement Permits and Authorized Research Activities on Wild Fish under Section 10(a)(1)(A) Permits.

Permit No. & Target Species	Location	Take Authorized	Research Activities
Atlantic Sturgeon *Permit No. 16526 Expires: 4/6/2017*	*Gulf of Maine Rivers & Coastal Areas*	*875 ATS adult/ sub-adult/juv, 300 ELS,* *3 Incidental mortalities*	*Capture, handle, measure, weigh, PIT tag, Floy/T-bar tag, tissue sample, internal tag, external tag, blood sample, apical spine sample, fin ray, anesthetize, borescope, lavage, collect ELS*
Shortnose Sturgeon *Permit No. 16306 Expires: 5/21/2017*	*Gulf of Maine Rivers & Coastal Areas*	*1,805 SNS adult/juvenile* *210 (Directed Mortality) ELS*	*Capture, handle, measure, weigh, tissue sample, PIT tag, surgery/acoustic tag, lavage, blood, fin ray ,anesthetize, collect ELS*
Shortnose Sturgeon *Permit No. 16549 Expires 4/1/2018*	*Upper Conn & GOM Rivers*	*300 SNS adult/juvenile* *150 (Directed Mortality) ELS*	*Capture, handle, measure, weigh, PIT tag, genetic tissue sample, borescope, anesthetize, and externally sonic tag, collect ELS*
Atlantic Sturgeon *Permit No. 16323 Expires: 4/6/2017*	*Lower Connecticut River &* *Long Island Sound*	*200 ATS adult/sub-adult & juveniles*	*Capture, handle, weigh, measure, PIT, Floy tag, acoustic tag, tissue sample, anesthetize, fin ray*
Atlantic Sturgeon *Permit No. 16422 Expires: 4/6/2017*	*Coastal Water (Long Island Sound to Delaware River)*	*325 ATS adult/sub-adult & juveniles*	*Capture, handle, measure, weigh, PIT, dart tag, tissue sample, fin- ray section, anesthetize, blood, gill biopsy, external/PSAT tag,*
Atlantic and Shortnose Sturgeon *Permit No. 16436-01 Expires: 4/6/2017*	*Hudson River & Estuary*	*2,113 ATS adult/sub-adult & juveniles 3 mortalities* *2,523 SNS adult/juveniles* *3 mortalities*	*Capture, handle, measure, weigh, dart tag, PIT tag, genetic tissue sample, anesthetize, gastric lavage, internal tag, external tag*
Atlantic and Shortnose Sturgeon *Permit No. 17095-01 Expires 8/28/2017*	*Hudson River (Utility Trawl)*	*200 ATS adult/ sub-adult & juveniles* *40 ATS ELS* *82- SNS adult/juveniles* *40 ELS*	*Capture, handle, measure, weigh, scan for tags, PIT tag, Dart tag, photograph, tissue sample, release,* *collect ELS*
Atlantic and Shortnose Sturgeon *Permit No. 16507-01 Expires: 4/6/2017*	*Delaware Coastal Waters* *& Delaware River*	*410 ATS adult/sub-adult & 100 juveniles* *350 ELS* *100 SNS juvenile*	*Capture, handle, weigh, measure, Floy, PIT, genetic tissue sample; anesthetize, fin ray section, gonad tissue sample, internal sonic tag, external satellite tag, collect ELS*

Appendix E. continued

Permit No. & Target Species	Location	Take Authorized	Research Activities
Atlantic and Shortnose Sturgeon Permit No. 19331 Expires: 6/30/2021	Delaware River & Estuary	530 ATS adult/sub-adult & juveniles 500 ELS 2 mortalities 500 SNS adult/juveniles 500 ELS 2 mortalities	Capture, handle, weigh, measure, Floy tag, PIT tag, genetic tissue sample, anesthetize, internal acoustic tag, gastric lavage, collect ELS
Atlantic and Shortnose Sturgeon Permit No. 19255 Expires 2/05/2021	Delaware River & Estuary	275 ATS adult/sub- adult/juv 1 mortality 75 SNS adult/ juvenile 1 mortality	Capture, handle, measure, weigh, Floy tag, PIT tag, tissue sample, anesthetize, internal sonic tag,
Atlantic Sturgeon Permit No. 16547-01 Expires: 4/6/2017	Chesapeake Bay and Tributaries (MD and VA)	475 ATS adult/sub- adult/juv 50 ELS, 3 mortalities	Capture, handle, measure, weigh, Floy, PIT tag, tissue sample, anesthetize, external sonic tag, internal sonic tag, collect ELS
Atlantic and Shortnose Sturgeon Permit No. 19642 Expires: : 6/30/2021	Chesapeake Bay and Tributaries, (MD, VA, DE) & Coastal Rivers and Marine	575 ATS adult/sub- adult/juv 500 ELS, 2 mortalities 100 SNS adult/juvenile 500 ELS 1 mortality	Capture, handle, measure, weigh, Floy, PIT tag, tissue sample, anesthetize, external sonic tag, internal sonic tag, collect ELS
Atlantic Sturgeon Permit No. 16375 Expires: 4/6/2017	North Carolina Rivers & Albemarle Sound	200 ATS adult/sub-adult/juvenile	Capture, handle, weigh, measure, PIT tag, Floy tag, genetic tissue sample, anesthetize, internal tag
Atlantic Sturgeon Permit No. 16442 Expires: 4/6/2017	South Carolina Rivers	350 ATS adult/sub-adult /juv 100 ELS	Capture, handle, measure, weigh, PIT dart tag, genetic tissue sample, anesthetize, internal acoustic tag, laparoscopy, blood sample, gonad biopsy, collect ELS
Shortnose Sturgeon Permit No. 15677 Expires:5/31/2017	South Carolina Rivers	154 SNS adult/juvenile 100 ELS	Capture, handle, measure, weigh, PIT dart tag, genetic tissue sample, anesthetize, internal acoustic tag, gonad biopsy, ELS

Appendix E. continued

Permit No. & Target Species	Location	Take Authorized	Research Activities
Atlantic and Shortnose Sturgeon *Permit No. 16482 Expires: 4/5/2017*	*Georgia/Florida Rivers & Estuaries*	*3,474 ATS adult/sub-adult & juvenile 250 ELS* *6 mortalities* *940 SNS adult/juvenile* *300 ELS*	*Capture, measure; weigh;* *PIT tag; Floy/T-bar tag; genetic tissue; anesthetize; blood sample, laparoscope, biopsy, internal/external tag, fin ray sample, lavage*
Atlantic Sturgeon *Permit No. 16508 Expires: 4/5/2017*	*Florida/Georgia Rivers & Estuaries*	*20 ATS St Marys, GA/FL* *20 ATS Nassau, FL* *20 ATS St. Johns, FL (Adult/sub-adult/juvenile)*	*Capture, handle, measure, weigh, tissue sample, PIT tag, Foy tag, external sonic tag*

Sawfish Handling and Release Guidelines

Keep as much of the sawfish in the water as possible.

Use extreme caution when handling and releasing sawfish as the saw can thrash violently from side to side

For sawfish caught on longline gear:

- **Use line cutting poles, boltcutters, long-handled de-hookers and boat hooks to aid in removing gear, including hooks, from the sawfish**
- **If the sawfish is hooked and not entangled, cut the line as close to the hook as possible. Remove the hook with a dehooker, if possible**
- **If the sawfish is hooked and line is tangled around the saw (rostrum), remove all line with a boat hook or line cutting pole, then cut the line as close to the hook as possible. Remove the hook with a de-hooker, if possible**
- **If hooked internally, do NOT attempt to remove the hook, use line cutting pole or boat hook to remove as much line as possible**

For sawfish caught in trawl or gill net gear:

- **DO NOT REMOVE THE FISH'S SAW (ROSTRUM)**
- **Leave the sawfish, especially the gills, in the water as much as possible**
- **Use line cutting pole or knife to cut any net tangled around the saw by cutting the mesh along the length of the saw**
- **Once mesh is cut, work it free with a boat hook or line cutting pole**

In your logbook, document as much information as possible including:

- Date and time of encounter
- Location (GPS coordinates)
- Habitat (water depth, bottom type)
- Estimated total length of sawfish including saw
- Description of gear that could not safely be removed from the animal
- Markings, scars, wounds
- If present, record tag number and type (shape and color) (tags are found on or below the dorsal fins), but do not remove the tag
- Details of capture (bait, hook size/type, mesh size, length of gear)
- Sex of sawfish, if known (male sawfish, like sharks, have two claspers at the base of the pelvic fins)

Do not remove the saw or injure the sawfish in any way.

With a little extra effort, and the proper use of required tools, endangered smalltooth sawfish can be returned to the water with little or no damage.

Smalltooth sawfish are listed as endangered under the Endangered Species Act and "take" of listed species is prohibited under section 9 of the Endangered Species Act. Any sawfish caught while fishing must be released as quickly as possible. More information can be found at http://www.nmfs.noaa.gov/pr/species/fish/smalltoothsawfish.htm

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