National Marine Fisheries Service
Endangered Species Act Section 7
Biological Opinion

Title:	Biological Opinion on the Issuance of Incidental Take Permit No. 23861 to Midwest Biodiversity Institute, Inc. for Annual Fish Assemblage Assessments conducted on the Lower Kennebec and Sebasticook Rivers in Maine
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 Agency:	Endangered Species Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
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TABLE OF CONTENTS

Page

List of Tables

Page

List of Figures

1 INTRODUCTION

The Endangered Species Act of 1973 (ESA), as amended (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 their actions 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 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 concurs with that determination for species under NMFS jurisdiction, consultation concludes informally (50 C.F.R. §402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize 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), which exempts take incidental to an otherwise lawful action, and specifies the impact of any incidental taking, including reasonable and prudent measures (RPMs) to minimize such impacts and terms and conditions to implement the RPMs.

The Federal action agency for this consultation is the NMFS, Office of Protected Resources, Endangered Species Conservation Division (hereafter the Endangered Species Conservation Division). The Endangered Species Conservation Division proposes the issuance of an Incidental Take Permit (ITP; Permit No. 23861) to Midwest Biodiversity Institute, Inc. (MBI). The permit would authorize the take of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon incidental to otherwise lawful operations associated with the MBI Fish Assemblage Assessment Surveys conducted on the Lower Kennebec and Sebasticook Rivers in Maine.

This consultation, biological opinion (opinion), and associated incidental take statement were completed in accordance with section 7(a)(2) of the statute (16 U.S.C. 1536 (a)(2)), associated implementing regulations (50 C.F.R. §§402.01-402.16), and agency policy and guidance. This consultation was conducted by the NMFS Office of Protected Resources (OPR) Endangered Species Act Interagency Cooperation Division (hereafter referred to as "we" or "our").

This document represents the NMFS opinion on the effects of the proposed action under Permit No. 23861 on Atlantic salmon (*Salmo salar*) Gulf of Maine (GOM) Distinct Population Segment (DPS), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) GOM and New York Bight (NYB)

DPSs, and shortnose sturgeon (*Acipenser brevirostrum*), and designated critical habitat for Atlantic salmon (GOM DPS) and Atlantic sturgeon (GOM and NYB DPSs).

A complete record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

Section 10(a)(1)(B) of the ESA allows for issuance of ITPs if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. MBI has conducted annual electrofishing surveys in the lower Kennebec River and Sebasticook River in Maine for the last 18 years. The purpose of the surveys are to document changes to fish assemblages in the rivers following the removal of the Edwards Dam in 2001 and the Fort Halifax dam in 2009. Fish sampling has occurred at seven sites in the Lower Kennebec River mainstem since 2002, and at three sites in the Lower Sebasticook River since 2008. All proposed sampling sites occur within the geographic range of the listed Atlantic salmon (GOM DPS), Atlantic sturgeon (GOM DPS and/or NYB DPS), and shortnose sturgeon. MBI has conducted the majority of the past work as a grantee or contractor to the U.S. Environmental Protection Agency (EPA). The previous work has been covered by five-year Incidental Take Statements with annual take limits issued under section 7 of the ESA since 2010, the most recent of which expired in 2019. The previous opinions from the ESA section 7 consultations conducted for each of the ITSs included Reasonable and Prudent Measures (RPM) for minimizing harm to individual fish for Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon, Terms and Conditions based on these RPMs for minimizing harm to individual fish, and requirements for reporting any incidental take to NMFS. The ITP (Permit No. 23861) proposed by the NMFS Endangered Species Conservation Division would authorize annual incidental take of five Atlantic salmon (adult), four Atlantic sturgeon (adult/subadult), and four shortnose sturgeon (adult/subadult) over ten years. No mortalities are authorized or expected for these species under the ITP based on evidence from the last 18 years of sampling using the same protocols that will be followed for the proposed action that have not resulted in mortality of captured animals.

MBI applied for an ITP on January 31, 2020, for takes of ESA-listed Atlantic salmon GOM DPS, Atlantic sturgeon GOM DPS and NYB DPS, and shortnose sturgeon associated with an otherwise lawful bioassessment survey to be conducted in the Lower Kennebec River. NMFS Endangered Species Conservation Division requested additional information from MBI and on March 30, 2020, MBI submitted a revised application. At that time, NMFS Endangered Species Conservation Division determined the ITP application was considered adequate and complete. On April 17, 2020, NMFS Endangered Species Conservation Division published a notice of receipt of the MBI application in the *Federal Register* (85 FR 21413). The comment period ended on May 18, 2020. NMFS Endangered Species Conservation Division and MBI held further discussions regarding information that would be incorporated in the Conservation Plan developed for the proposed action. On July 6, 2020, NMFS Endangered Species Conservation Division received a final application from MBI.

1.2 Consultation History

This opinion is based on information provided in the permit application, correspondence, and discussions with the Endangered Species Conservation Division and the applicant, as well as similar opinions and annual reports from the previous research activities for which we have conducted ESA section 7 consultations.

Our communication with the Endangered Species Conservation Division regarding this consultation is summarized as follows:

- On July 27, 2020, the NMFS Endangered Species Conservation Division sent a memorandum requesting formal consultation to the NMFS Interagency Cooperation Division.
- On September 3, 2020, we determined there was sufficient information to initiate formal consultation and sent NMFS Endangered Species Conservation Division an initiation memorandum.

2 THE ASSESSMENT FRAMEWORK

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

"Jeopardize the continued existence of" 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 C.F.R. §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species as a whole (50 C.F.R. §402.02).

This ESA section 7 consultation involves the following steps:

Description of the Proposed Action (Section 3): We describe the proposed action and those aspects (or stressors) of the proposed action that may affect the physical, chemical, and biotic environment. This section also includes any avoidance and minimization measures that have been incorporated into the proposed action to reduce the effects of the action on ESA-listed species or designated critical habitat.

Action Area (Section 3.4): We describe the action area as the area within the spatial extent of the stressors resulting from the proposed action.

Potential Stressors (Section 0): We identify the stressors that could occur as a result of the proposed action and affect ESA-listed species and designated critical habitat.

Status of Species and Critical Habitat in the Action Area (Section 6): We identify the ESA-listed and designated critical habitat present in the action area that are likely to co-occur with the stressors from the action in space and time. We also identify the species and critical habitat that are Not Likely to be Adversely Affected by the stressors and detail our effects analysis for these species and habitats.

Species Likely to be Adversely Affected by the Proposed Action (Section 7): We identify the status of ESA-listed species and designated critical habitat that are Likely to be Adversely Affected by the stressors resulting from the proposed action. *Environmental Baseline* (Section 8): We describe the environmental baseline as the condition of the listed species in the action area, without the consequences to the listed species caused by the proposed action. 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. The consequences to listed species from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Effects of the Action (Section 9): Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. These are broken into analyses of exposure, response, and risk, as described below for the species that are likely to be adversely affected by the action.

In the Risk Analysis, we evaluate the potential adverse effects of the action on ESA-listed species and designated critical habitat. To do this, we being with problem formulation that integrates the stressors of the action with the species' status (Section 7) and the Environmental Baseline (Section 8) and formulate risk hypotheses based on the anticipated exposure of listed species and critical habitat to stressors and the likely response of species and habitats to this exposure. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure, as well as the response of critical habitat to exposure to stressors. 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 sub-populations to which those individuals belong. We also consider whether the action will result in impacts to the essential physical and biological features (PBFs) and conservation value of designated critical habitat. We assess the consequences of the responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise.

Cumulative Effects (Section 10): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 C.F.R. §402.02). Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Section 11): With full consideration of the status of the species, we consider the effects of the proposed action within the action area on populations or subpopulations when added to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of an ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

The results of our jeopardy and destruction or adverse modification analyses are summarized in the Conclusion (Section 12).

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, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (See 50 C.F.R. §402.14(h)(3)).

An *Incidental Take Statement* (Section 13) is included for those actions for which take of ESA-listed species is reasonably certain to occur in keeping with the revisions to the regulations specific to ITSs (80 FR 26832, May 11, 2015; ITS rule). The ITS specifies the impact of the incidental take, reasonable and prudent measures to minimize the impact of the incidental take, and terms and conditions to implement the reasonable and prudent measures (ESA section 7(b)(4); 50 C.F.R. §402.14(i)). We also provide discretionary conservation recommendations that may be implemented by action agency (Section 14) (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which reinitiation of consultation is required (Section 15) (50 C.F.R. §402.16).

2.1 Evidence Available for the Consultation

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of *Google* Scholar, literature cited sections of peer-reviewed articles, species listing documentation, and reports published by government and private entities. This opinion is based on our review and analysis of various information sources, including:

- Information submitted by the NMFS Endangered Species Conservation Division and the applicant;
- Government reports (including NMFS opinions, recovery plans, and stock assessment reports);
- National Oceanic and Atmospheric Administration (NOAA) technical memoranda;
- Annual reports from previously-permitted research; and
- Peer-reviewed scientific literature.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of the PBFs of designated critical habitat for the conservation of ESA-listed species.

3 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 proposed action for this consultation is NMFS Endangered Species Conservation Division's issuance of an ITP to MBI pursuant to the requirements of the ESA.

The Endangered Species Conservation Division proposes to issue ITP No. 23861 to MBI to cover incidental take of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon that may occur while MBI conducts annual electrofishing surveys in the lower Kennebec River and Sebasticook River in Maine. The purpose of these surveys is to document changes to fish assemblages in the rivers. These surveys have been conducted for the past 18 years following the removal of the Edwards Dam in 2001 and the Fort Halifax dam in 2009. The Ten, one kilometer-long (0.6 mile) sampling sites or transects occur within the geographic range of the listed Atlantic salmon (GOM DPS), Atlantic sturgeon (GOM DPS and/or NYB DPS), and shortnose sturgeon. MBI has conducted the majority of the past work as a grantee or contractor to the EPA and the project has been covered by five-year ITSs issued under Section 7 of the ESA since 2010; the most recent of which expired in 2019. MBI is applying for an ITP in accordance with the requirements under Section 10(a)(1)(B) of the ESA. The sampling plan that was used submitted in application for the ITP can be accessed on NMFS ITP webpage: Incidental Take Permit to MBI permit No. 23861. The permit would expire ten years after the date of issuance. Information regarding the operation of MBI surveys, including the use of electrofishing and vessels discussed below, was obtained from MBI's ITP application (MBI 2020).

3.1 Electrofishing Methodology

Electrofishing methods entail passing an electric current through the water to capture or control fish. The electric current causes fish within the effective area of the electric field to become temporarily stunned or immobilized (referred to as electrotaxis) to facilitate capture by nets.

The sampling vessel consists of a five to 5.5 meter(16 to18 feet)-long flat-bottom john boat equipped with a 10 to 25 horsepower engine (specifically constructed and modified for electrofishing), the electrofishing generator (pulsed direct current (DC) electrofishing apparatus), and bow-mounted electrode array (

Figure 1). In shallow water areas, a smaller 4.2 meter (14 feet) raft is used for the electrofishing. The john boat electrofishing crew consists of a boat driver and two netters; the raft crew consists of a raft driver and one netter.

Vessel speeds are variable and for the john boat can range from five to 10 miles per hour (4.3 to 8.6 knots) during transits to and from sampling locations when necessary. During electrofishing surveys, the boat drifts downstream with occasional powered movements to negotiate obstacles and increase transect coverage.

Electric current from the generator is converted, controlled, and regulated by a Smith-Root 2.5 or 5.0 generator-powered pulsator that produces up to 1,000 volts DC at 2-20 amperes, depending on the relative conductivity of the river. The pulse configuration consists of a fast-rise, slow-decay wave that can be adjusted to 30, 60, or 120 Hertz (pulses per second). Generally, electrofishing is conducted at 60 or 120 Hertz, depending on which selection is producing the optimum combination of voltage and amperage output that most effectively and safely stuns fish. The voltage range is selected based on what percentage of the power range produces the highest amperage readings. Generally, the high range is used at conductivity readings less than 50 to 100 microsecond per square centimeter, and the low range is used at higher conductivities up to 1,200 microsecond per square centimeter.

The electrode array on the john boat consists of four 2.5 meter (8.5 feet)-long cathodes (negative polarity; 2.5 centimeter [1 inch] diameter flexible steel conduit) suspended from the bow and either two or three gangs of anodes (positive polarity), depending on the conductivity of the water, suspended from a retractable aluminum boom. The raft configuration is similar, except there are six cathodes in two gangs of three suspended from the sides of the raft. In both platforms, the gangs of anodes consist of four 3/8 inch (0.95 centimeter) woven steel cable strands (each 1.23 meter [4 feet] in length) formed into a "gang" by binding them together near the attachment point on the boom. These gangs are added or detached as conditions change; anodes are increased (three gangs) at low conductivity and reduced (two gangs and/or fewer wires) at high conductivity. The anodes are suspended from a retractable aluminum boom that extends 2.75 meters (9 feet) in front of the bow on the john boat and 2.5 meters (8.2 feet) on the raft. The width of both arrays is 0.9 meters (2.96 feet). Anodes and cathodes are replaced when they are lost, damaged, or become worn.

3.1.1 Sampling Procedure

During sampling, the electrofishing vessel (john boat or raft) will make a single pass along each transect, traveling approximately one kilometer (0.6 miles) along the shoreline. Electric current will be applied to maintain power densities sufficient to generate electrotaxis in targeted fish (*i.e.,* shad, salmon, sturgeon, and eels). Minimum settings will be estimated by measuring water conductivity and evaluating behavioral responses of fish prior to changing settings. Efforts to adjust settings will favor low frequency and pulse width to minimize any injuries to fish. Target electrical currents are two to four amps, 400 volts, and 60 pulses per

second. Based upon these settings, the expected range of electrotaxis for fish in the electric field will be approximately 4.5 meters (15 feet) in diameter down to a depth of approximately 2.5 meters (8.2 feet). During sampling, the anode and cathode will be held as far apart as practical to generate a more diffuse field in order to minimize the risk of injury to fish. Stunned fish will be captured using hand-held nets and removed from the water as rapidly as possible. ESA-listed species (*i.e.,* salmon and sturgeon) will not be netted or handled unless immobilized and/or in apparent distress. In these instances, the fish may be netted or otherwise handled in order to ascertain any injury and to revive if necessary, but the fish will not be removed from the water.The electrofishing method as described is most effective along the shoreline and adjacent to hard structures such as bedrock ledges, woody debris, and hard substrates. The effective extent of the electric field is species-dependent, based on the susceptibility of each species to the electric field. The size of individual fish also affects their susceptibility to being influenced by the electric field. Generally, larger fish are the most susceptible, as the voltage gradient increases with length, but the method is generally effective for all sizes of fish greater than 25 centimeters (10 inches).

Figure 1. The electrofishing boat used by MBI to sample fish assemblages in the Lower Kennebec River showing the electrofishing booms with the umbrella anode dropper and bow cathode curtain arrays.

For boat and raft electrofishing at individual sampling locations, the accepted procedure is to slowly and methodically maneuver the electrofishing boat in a down-current direction along the shoreline, maneuvering in and around submerged cover to advantageously position the netters to pick up stunned and immobilized fish. This may require frequent turning, backing, shifting between forward and reverse, changing speed, etc., depending on current velocity and cover density and variability. Although sampling effort is measured by distance, the time fished is an important indicator of adequate effort. Time fished can vary over the same distance, as dictated by cover and current conditions and the number of fish encountered. In all cases, there is a minimum time that should be spent sampling each zone regardless of the catch. In practice, this is generally in the range of 2,000 to 2,500 seconds for 0.5 kilometer (1,640 feet), but could range upwards to 3,500 to 4,000 seconds where there is extensive instream cover and slack flows. For the one kilometer (0.6 mile) standard distance, the minimum sampling time was determined to be from 3,000 to 4,000 seconds for impounded and tidal sites and 3,500 to 4,500 seconds or more at riverine sites.

Netters are required to wear polarized sunglasses to facilitate seeing stunned fish in the water during each daytime boat electrofishing run. A boat net with a 2.5 meter (8.2 feet) long handle and 7.62 millimeter (0.3 inch) Atlas mesh knotless netting is used to capture stunned fish as they are attracted to the anode array and/or stunned. A concerted effort is made to capture every fish sighted by both the netters and driver. Because the ability of the netters to see stunned and immobilized fish is partly dependent on water clarity, sampling is conducted only during periods of “normal” water clarity and flows. Periods of high turbidity and high flows are avoided due to their negative influence on sampling efficiency. If high flow conditions prevail, sampling will be delayed until flows and water clarity return to seasonal, low flow norms.

Captured fish (non-ESA-listed) are immediately placed in aerated live wells containing ambient river water. Each transect typically takes 45 minutes to complete, with an additional 45 minutes to process all of the fish captured. The total time fish are held varies; fish are processed after each transect and the maximum holding time for any one fish could be 90 minutes. Captured fish are identified to species, weighed, enumerated, and released alive.

3.1.2 Sampling Levels

Ten, one kilometer-long (0.6 mile) sampling sites or transects are located immediately adjacent to the shoreline or submerged features such as bedrock ledges and gravel shoals, Seven sites are located within the 17.5 miles (28.2 kilometers) of the Lower Kennebec River and three sites are found within six miles (9.7 kilometer) of the Lower Sebasticook River (Figure 2). Generally, the deepest side of the river with the best combination and heterogeneity of habitat, flow, and structural cover is thoroughly sampled. A one kilometer (0.6 mile) site typically requires between 3600 and 5400 seconds of “current time,” *i.e.,* the cumulative time that the electric field is activated within a site (the netters operate a foot pedal switch, and current is applied intermittently). The variance in time fished is affected by site navigability, current velocity, current types, boat maneuverability, and the number of fish collected. Individual electrofishing sites are located along the shoreline with the most diverse habitat features, in accordance with established methods (Ackerman 1997; Yoder et al. 2006a; Yoder et al. 2006b). This is generally along the gradual outside bends of larger rivers, but it can vary. Sampling distance is determined with a global positioning system unit and/or laser range finder.

3.1.3 Field Sample Processing Procedures

Water in the live wells where non-ESA-listed fish are placed for processing is replaced regularly in warm weather to maintain adequate dissolved oxygen levels in the water and to minimize mortality. Aeration will be provided to further minimize stress and mortality. Every effort is made to minimize holding and handling times. Standard handling procedures – provided by the Maine Department of Marine Resources (MEDMR) – are employed for all non-listed species.

Fish that are not retained for voucher or other purposes are released back into the water after they are identified to species, examined for external anomalies (e.g. lessions, cuts, abbrasions, etc.), and weighed.

When encountered, adult Atlantic salmon or sturgeon would not be netted or handled and the electric current would be turned off for five minutes, or until the fish recovers and moves out of the sampling area (whichever is longer). Any size estimates of ESA-listed species would be made visually with the fish remaining in the river and without handling the fish.

Fish weighing less than 1,000 grams (35.3 ounces) are weighed to the nearest gram on a spring dial scale or a hand held spring scale. Fish weighing more than 1,000 grams (35.3 ounces) are weighed to the nearest 25 grams (0.9 ounces) on a 12 kilogram (26.5 pound) spring dial scale or a 50 kilogram (110 pound) hand held spring scale. For samples comprised of two or more distinct size classes of fish of the same species, such as young of the year, juveniles, and adults, the size classes are processed separately.

The majority of captured fish are identified to species in the field; however, if there is any uncertainty about the field identification of a non-ESA-listed fish, the fish will be preserved for later laboratory identification. Retained fish are also measured for total length prior to preservation.

Fish to be kept are preserved in borax-buffered ten percent formalin for future identification and labeled by date, river or stream, and geographic identifier (e.g., river mile). Non-indigenous species may be kept and appropriately disposed of out of the water, per the request of the state management agencies.

3.2 Activity Dates

The sampling protocol specifies that riverine fish sampling be conducted within a seasonal index period of July 1 to September 30. However, for the Lower Kennebec River study, the end the seasonal index period has been extended into October to coincide with the peak of out-migrating river herring, particularly alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*). In most years, the first sampling pass has occurred between late August and mid-September and the second pass in early to mid-October. Based on recent research and information provided by MEDMR (Kynard and Horgan 2002; Wippelhauser and Squiers 2015; Wippelhauser et al. 2015), sampling will be delayed until after mid-September to better avoid early life stages and juveniles of shortnose sturgeon and also to insure that water temperatures are below the recommended maximum of 22 degrees Celsius (71.6 degrees Farhenheit) for Atlantic salmon. Each Lower Kennebec River sampling pass requires two to three days to accomplish with up to four sites being sampled in a day. Sampling the Sebasticook River adds another day to the schedule, but this has been precluded by recurrent low flows since 2016. Efforts will be made to resume this survey in the future.

3.3 Conservation Measures

The following minimization and avoidance measures are required:

1. Conduct sampling between mid-September and mid-October to minimize any encounters with early life stage or juvenile fish as required by MEDMR.
2. MBI will request any recent acoustic detections of ESA-listed species in the study area and take steps to avoid any congregations of ESA-listed species.
3. Only trained and qualified MBI crew leaders and either MBI or MEDMR agency technicians will be allowed to carry out the sampling activities. The MBI crew leader will review the ESA-listed species minimization and avoidance procedures with the sampling crew at the beginning of each sampling day. In addition MEDMR procedures (Bruchs et al. 2016) for electrofishing will be included in the training and instructions.
4. Sampling and the operation of the electrofishing gear will be done in a manner that minimizes the potential for injury to ESA-listed species. The pulse frequency will be reduced to 30 to 60 hertz when sampling in areas of prior interaction with ESA-listed species to minimize the risk of injury.
5. Electric current and sampling activity will cease upon an encounter where an ESA-listed species is observed to be affected by the electric field. Affected sturgeon, if immobilized and/or in apparent distress, may be netted or otherwise handled in order to ascertain any injury and to revive, if necessary, but the individual will not be removed from the water. Affected ESA-listed fish that leave the electric field under their own power and appear to be uninjured will not be pursued and netted. In such cases, the species identification and estimation of length will be made visually.
6. Sampling will not be conducted when ambient water temperature is greater than 22° Celsius per MEDMR specifications (Bruchs et al. 2016). Temperature will be routinely measured at the start of each electrofishing site, but will be more frequently monitored (every two hours) when temperatures are between 20 to 22 degrees Celsius (68 to 71.6 degrees Farhenheit).
7. When there is any interaction with an ESA-listed species, all sampling activities will cease and the electric current will be shut off for a period of five minutes and/or until the individual fish are released (if captured) and determined to have departed the area. Notation will be made about the physical condition of the individual in terms of the reaction to the electric field and if it was able to leave the area under its own power. Photographs will be taken of each interaction to document occurrence and any evidence of injury.

3.4 Reporting Requirements

The reporting requirements under the ITP include:

1. *Take Reports.* All protected species' incidental take during sampling must be reported to the Chief, Endangered Species Conservation Division, Office of Protected Resources,

NMFS, via email (angela.somma@noaa.gov) within 24 hours of occurrence. Reports of incidental take should include the date of the take, the condition of the fish, the species (if known), and any other pertinent details of the circumstances of the taking, as well as estimated fork length (centimeters); photographs; voltage in use; and documentation of any external tags or markings.

2. *Annual Reports.* A report of all protected species encountered during the sampling season must be submitted within 90 days following the end of each sampling season. The annual report must include:

    1) Annual take of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon during activities authorized by the permit;
    2) An annual data set compiled from the data collected during sampling, including days sampling occurred, locations, and water temperatures;
    3) Processed fish assemblage data (e.g., data quality and control have been completed); and
    4) A narrative describing any issues encountered during the year that interfered with implementation of the conservation plan including a description of any corrective actions taken or any proposed issue resolution.

3. *Final Report*. The Permit Holder must submit a final report within 180 of the expiration of the ITP summarizing the total take that occurred under the permit and the circumstances surrounding it. Reports must be submitted to the Endangered Species Conservation Division and Interagency Cooperation Division.

4 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 C.F.R. §402.02).

The action area for this consultation is all areas where proposed fish sampling activity will take place. These include seven one kilometer (0.6 mile)-long sites in a 28.2 kilometer (17.5 mile) stretch of the Lower Kennebec River and three one kilometer (0.6 mile)-long sites in a 9.7 kilometer (six mile) stretch of the Lower Sebasticook River (Figure 2). The action area is further defined as the 28.2 kilometer (17.5 mile) reach of the Lower Kennebec River between the Lockwood Dam and Hydropower Project in Waterville, Maine to the former Edwards Dam site in Augusta, Maine and a 9.7 kilometer (six mile) reach of the Sebasticook River (2008 through 2019) between the Benton Falls Dam and Hydropower Project in Benton Falls, Maine to the mouth at the Kennebec River in Winslow, Maine (Figure 2). The proposed action will involve running multiple transects along the shoreline at specific locations in the two rivers. Each transect will result in an electric field 4.5 to 5.5 meters (4.9 to 6 feet) wide, 2.5 to 3.5 meters (2.7

to 3.8 feet) deep, and one kilometer (0.6 miles) long (see Table 1). The proposed action is not expected to have any consequences to ESA-listed species outside of the ten discrete areas where electric current may be experienced.

These sites will be sampled twice annually for a cumulative total of approximately 20 kilometers (12.4 miles) of sampling effort over 37.9 kilometers (23.5 miles) of river. While this comprises 26.4 percent of the linear distance of the river, the exposure of the river and its fishes to electrofishing takes into account the time of exposure to electric current versus the time of not being exposed within the range of dates between the first and second passes. This is calculated by taking the number of days between the beginning of the first and end of the second passes which for 2020 would be 26 days between September 15 and October 15 for a total of 21,600 hours. The sampling effort was determined by taking the average time that the electric current is active at a site (4,000 seconds or 1.11 hours) times the 20 total kilometers (12.4 miles) of cumulative sampling distance which is 22 total hours. This results in the fishes of the study area being potentially exposed 0.10 percent of the time. This analysis is inherently one-dimensional and does not take into account the fact that the electric field is only exposing a fraction of the three-dimensional width and depth of each river thus the exposure risk is actually much less than the one-dimensional analysis.

The section 7 opinions for the 2011 through 2015 and 2015 through 2019 Lower Kennebec projects (NMFS 2011; NMFS 2015), in their assessment of the "Action Area", assumed that the electric field occupied an area of 3.5 to 4.5 meters (11.5 to 14.8 feet) in width and 2.5 to 3.5 meters (8.2 to 11.5 feet) in depth over a length of one kilometer (0.6 mile).

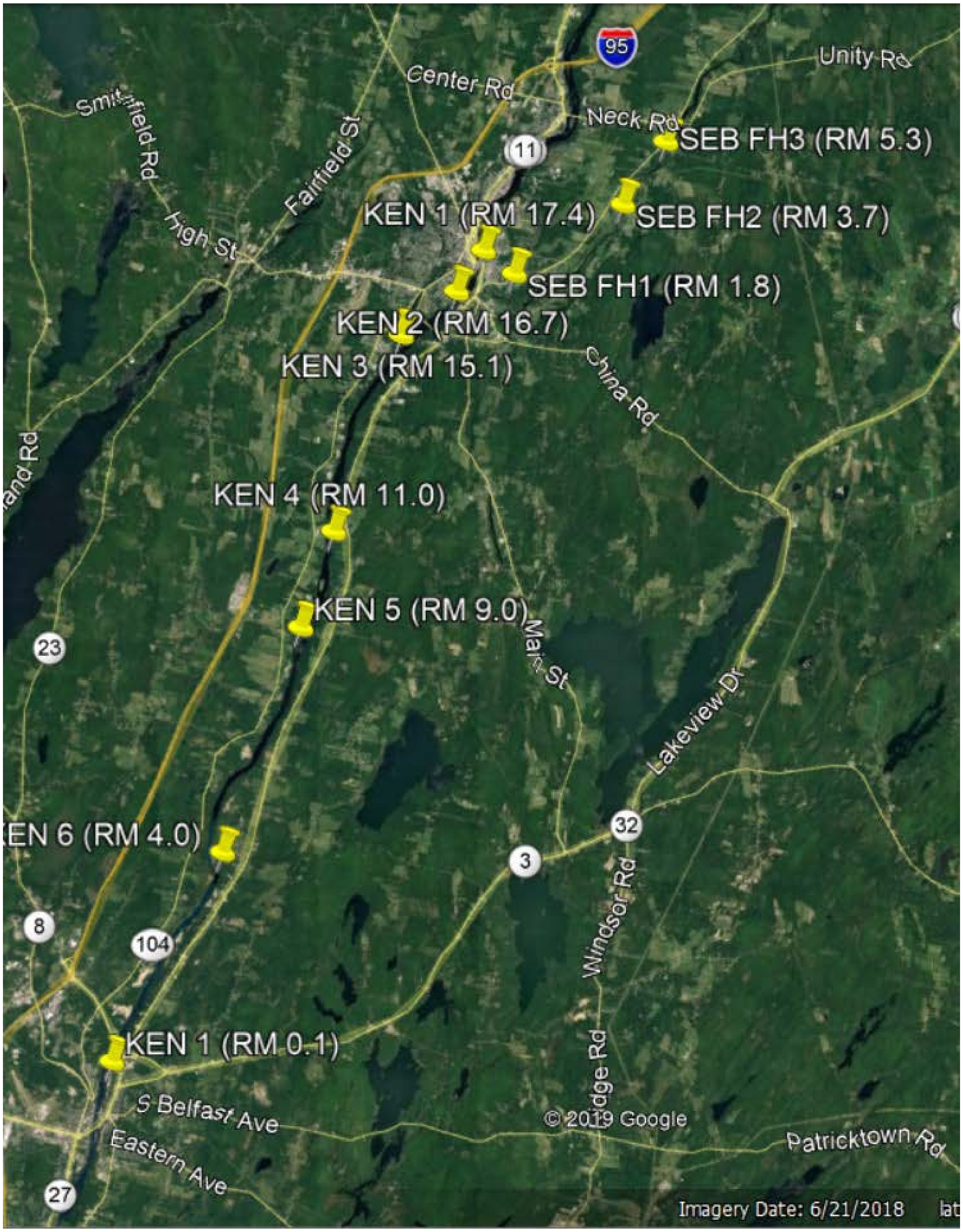

Figure 2. Map of the survey area and significant landmarks. The Lower Kennebec and Sebasticook Rivers study area showing fish sampling sites with site codes and river miles (see Table 1), major highways, and other landmarks between Waterville and Augusta, Maine.

Table 1. List of sampling locations in the Lower Kennebec River and Lower Sebasticook Rivers 2002 through 2019 and proposed for 2020 through 2029. Each site is sampled for fish twice during a late summer-early fall seasonal index period. The sites are georeferenced by river mile (distance upstream from the head of tide – defined as the downstream side of Lockwood Dam to the downstream side of the power lines located about 1.3 kilometers (4,200 feet) above the Calumet Bridge in Augusta, Maine) and by coordinates at the center of a 1.0 kilometer (0.6 mile) sampling zone.

River	RM	Latitude	Longitude	Location Description
Kennebec River	17.4	44.545190	-69.627667	Immediately dst. Lockwood Dam & Hydro Project
Kennebec River	16.7	44.533984	-69.637951	Dst. Sebasticook River
Kennebec River	15.1	44.522228	-69.659059	Petty's Rips - dst. Waterville WWTP
Kennebec River	11.0	44.468922	-69.684662	Sixmile Falls
Kennebec River	9.0	44.442891	-69.697161	Upstream Sidney boat launch
Kennebec River	4.0	44.381757	-69.726756	Sevemile Island
Kennebec River	0.1	44.324932	-69.768608	Brackets former Edwards Dam site - Augusta
Sebasticook River	5.3	44.574695	-69.558276	Ust. tip of island Dst. Benton Falls Dam
Sebasticook River	3.7	44.557685	-69.574625	Middle site at twin islands
Sebasticook River	1.8	44.538866	-69.616010	Ust. Fort Halifax Dam site

RM=river mile, dst=downstream, ust=upstream

5 POTENTIAL STRESSORS

Stressors are any physical, chemical, or biological entity that may directly or indirectly induce an adverse response either in an ESA-listed species or their designated critical habitat. During consultation, we identify stressors that are reasonably certain to result from the proposed action. There are several potential stressors that we expect to occur because of the proposed actions resulting from the issuance of ITP No. 23861.

Potential stressors from the proposed action include: exposure to the electric current from sampling methodology (electrofishing); vessel strikes; vessel noise; and exposure to pollution (fuel and oil spills) from vessel activities.

Exposure to electric current is a direct result of the sampling methodology and effects are temporary and rarely result in mortality of fish. Vessel strikes present stressors of direct physical contact and trauma incurred during transit to the sampling locations. The stressor from vessel noise would be engine noise that enters the water as a result of the vessel transiting to reach sampling locations and/or maneuver among sampling sites. Pollution from oil or fuel spills from the sampling vessel would result in exposure to contaminants.

6 Status of the Species and Critical Habitat in the Action Area

This section identifies the ESA-listed species and designated critical habitat under NMFS jurisdiction that may occur within the action area. This section first identifies the species that may be affected, but are not likely to be adversely affected by the proposed action. The remaining species deemed likely to be adversely affected by the proposed action considered in this opinion are carried forward through the remainder of this opinion.

Table 2. Endangered Species Act-listed threatened and endangered species and designated critical habitat potentially occurring in the action area that may be affected, but are not likely to be adversely affected by the National Marine Fisheries Service Endangered Species Conservation Division's proposed action of issuance of incidental take permit No. 23861 to Midwest Biodiversity Institute.

Species	ESA Status	Critical Habitat	Recovery Plan
	Fish		
Atlantic Salmon (*Salmo salar*) – Gulf of Maine DPS	E – 74 FR 29344 and 65 FR 69459	74 FR 39903	70 FR 75473 and 81 FR 18639 (Draft) 11/2005 03/2016 – Draft 2/2019- Final
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Gulf of Maine DPS	T – 77 FR 5879	82 FR 39160	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – New York Bight DPS	E – 77 FR 5879	82 FR 39160	-- --
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 FR 4001	-- --	63 FR 69613 12/1998

DPS=Distinct Population Segment, E=Endangered, T=Threatened, FR=*Federal Register*

6.1 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. 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 habitat that co-occur with a potential stressor but are not likely to respond to the stressor are also not likely to be adversely affected by the proposed action. We applied these criteria to the species ESA-listed in Table 2 and we summarize our results below.

The probability of an effect on a species or designated critical habitat is a function of exposure intensity and susceptibility of a species to a stressor's effects (i.e., probability of response). An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly *beneficial*, *insignificant* or when effects are extremely unlikely to occur. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat. *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. For an effect to be extremely unlikely to occur, 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 affect a listed species or designated critical habitat), but this effect is extremely unlikely to occur.

If the effects of an action are determined to be wholly beneficial, insignificant, or when effects are extremely unlikely to occur, we conclude that the action is not likely to adversely affect ESA-listed species or designated critical habitat. This same decision model applies to individual stressors associated with the proposed action, such that some stressors may be determined to be not likely to adversely affect ESA-listed species or critical habitat because any effects associated with the stressors will be beneficial, insignificant, or extremely unlikely to occur.

In this section, we evaluate effects to ESA-listed species and designated critical habitat from stressors caused by the proposed action that may affect, but are not likely to adversely affect listed species and designated critical habitat.

6.2 Endangered Species Act-Listed Fish

GOM DPS of Atlantic salmon, GOM DPS of Atlantic sturgeon, NYB DPS of Atlantic sturgeon, and shortnose sturgeon may occur in the proposed action area and may be affected by the proposed action in the Kennebec River and Sebasticook River. The potential stressors that are not likely to adversely affect these ESA-listed fish species are discussed further in Section 6.3.3.

6.2.1 Potential Stressors to Endangered Species Act-Listed Fish

Potential stressors that are not likely to adversely affect ESA-listed fish include pollution, vessel strike, and vessel noise.

6.2.1.1 Pollution

The potential for an oil or fuel spill to emanate from the research vessel during the MBI's proposed action is small. An oil or fuel leak will likely pose a significant risk to the research vessel and its crew and actions to correct a leak should occur immediately to the fullest extent possible. In the event that a leak should occur, the amount of oil or fuel onboard the research vessel is unlikely to cause widespread, high-dose contamination (excluding the remote possibility of severe damage to the research vessel) that will impact ESA-listed species directly or pose hazards to their food resources. If a discharge occurs, the amount of leakage will be small, and will be expected to disperse quickly in the water and not affect ESA-listed species directly. We find the possibility for oil or fuel leakage to be extremely unlikely to occur. Therefore, we conclude that pollution by oil or fuel leakage is not likely to adversely affect ESA-listed species.

6.2.1.2 Vessel Strike

While vessel strikes of fishes during electrofishing or transiting to sample locations are possible, we are not aware of any definitive case of a fish being struck by a research vessel associated with electrofishing or transiting to sample locations. The research vessel will be traveling at generally slow speeds and the probability of a vessel strike are considered low given the type of sampling vessel (i.e., flat-bottomed boat) (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Our expectation of vessel strike for a fish is small due to the history of the previous 18 years of research conducted without a recorded vessel strike, the general expected movement of fish away from or parallel to the research vessel, as well as the generally slow movement of the research vessel during most of its travels. The research vessel will drift during normal sampling at the speed of the current – with slight minor adjustments of the throttle to steer and achieve maximum sampling coverage of a sample location. Transits to or from the first/last sampling location (furthest upstream/downstream) would occur at an operating speed of typically 8 to 16.1 kilometers per hour (5 to 10 miles per hour), depending on water depth and obstacles in the water. Balazik et al. (2012) states that Atlantic sturgeon spend the majority of the time in deeper, coolers waters within 1 meter (3.3 feet) of the bottom, and the research vessel used during the proposed action will have a shallow draft (keel of vessel does not extend more than 12 inches [30.5 centimeters]). Because of the small size of the research vessel, shallow draft, past record of sampling with no reported vessel strikes using the same methods as the proposed action, and slow speed of transit between sites, we do not anticipate any vessel strikes to occur from the proposed action. Furthermore, adherence to observation and avoidance procedures is also expected to avoid vessel strikes. With all factors considered, we have concluded the potential for vessel strikes from the research vessel are extremely unlikely to occur. Therefore, vessel strikes may affect, but are not likely to adversely affect ESA-listed Atlantic sturgeon (GOM and NYB DPSs), Atlantic salmon (GOM DPS), and shortnose sturgeon.

6.2.1.3 Vessel Noise

The overall contribution of vessel noise by the research vessel is likely small in the overall regional sound field in the action area. The research vessel's passage past ESA-listed fish will be brief, at a distance of approximately 5.5 meters (18 feet), and not likely to measurably impact any individual's ability to feed, reproduce, or avoid predators. In addition, the research vessel will travel at slow speeds, reducing the amount of noise produced by the propulsion system (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007).

Transiting vessels produce a variety of sounds characterized as low-frequency, continuous, or tonal, with sound pressure levels at a source varying according to speed, burden, capacity, and length (Kipple and Gabriele 2007; McKenna et al. 2012; Richardson et al. 1995). The exact level of noise produced varies by vessel type. While such vessel noise will not physically obstruct water passage or affect water properties, depth, wake, or benthic, and algal features, it may affect prey in designated critical habitat. The vast majority of fishes do not show strong responses to low frequency sound. Because of the characteristics of vessel noise, sound produce by research vessels is unlikely to result in direct injury, hearing impairment, or other trauma to fishes. Behavioral and/or physiological response can occur. The only impacts expected from exposure to vessel nosie for fishes may include temporary auditory masking, short-term physiological stress, or minor changes in behavior. These effects will be highly localized and temporary. Although avoidance behavior in prey may lead to a change in distribution, any such change will be short-lived, likely lasting only while the research vessel is in the action area.

Because the potential acoustic interference from engine noise is expected to be nearly undetectable or so minor that it cannot be meaningfully evaluated, we find that the risk from this potential stressor on ESA-listed species is insignificant. Therefore, we conclude that vessel noise may affect, but is not likely to adversely affect ESA-listed species.

6.3 Endangered Species Act-Listed Critical Habitat

The proposed action area lies within the designated critical habitat for GOM DPS of Atlantic salmon and GOM DPS and NYB DPS of Atlantic sturgeon, and these habitats may be affected by the proposed action. As noted above, critical habitat includes those physical and biological features essential to the conservation of the species which may require special management considerations or protection. Physical or biological features are defined as "the features that support the life history needs of the species including water charcteristics, soil type, geological features, sites, prey, vegetation, symbiotic species, or other features" (NMFS 2017).

6.3.1 Atlantic Salmon – Gulf of Maine Distinct Population Segment Critical Habitat

In 2009, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for Atlantic salmon (74 FR 29300). The critical habitat 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 (Figure 3).

Essential physical and biological features were identified within freshwater and estuarine habitats of the occupied range of the GOM DPS of Atlantic salmon and include sites for spawning and incubation, junvenile rearing, and migration. The final rule also identified three salmon habitat recovery units to identify geographic and population-level factors to aid in managing the habitat: Merrymeeting Bay, Penobscot, and Downeast. Critical habitat and essential physical and biological features were not designated within marine environments because of the limited knowledge of these elements that the species uses during the marine phase of its life.

Physical and biological features of spawning and rearing:

1. Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they away spawning in the fall.
2. Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.
3. Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.
4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
5. Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.
6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.
7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and biological features of migration:

1. Freshwater and estuary migratory sites free and physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recoverd populations.
2. Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.
3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.
5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.
6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

Habitat areas designated as critical habitat must contain one or more physical and biological features within the acceptable range of values required to support the biological processes for which the species uses that habitat. Critical habitat includes all perennial rivers, streams, and estuaries and lakes connected to the marine environment within the range of the GOM DPS of Atlantic salmon, except for those areas that have been specifically excluded as critical habitat. Critical habitat includes the stream channels within the designated stream reach and includes a lateral extent as defined by the ordinary high-water line or the bankfull elevation in the absence of a defined high-water line. In estuaries, critical habitat by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or elevation of extreme high water, whichever is greater.

For an area containing primary constituent elements to meet the definition of critical habitat, the ESA also requires that they physical and biological features essential to the conservation of Atlantic salmon in that area "may require special management considerations or protections." Activities within the GOM DPS of Atlantic salmon that were identified as potentially affecting the physical and biological features of salmon habitat and, therefore, requiring special management considerations or protections include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-stream crossings, mining, dredging, and aquaculture.

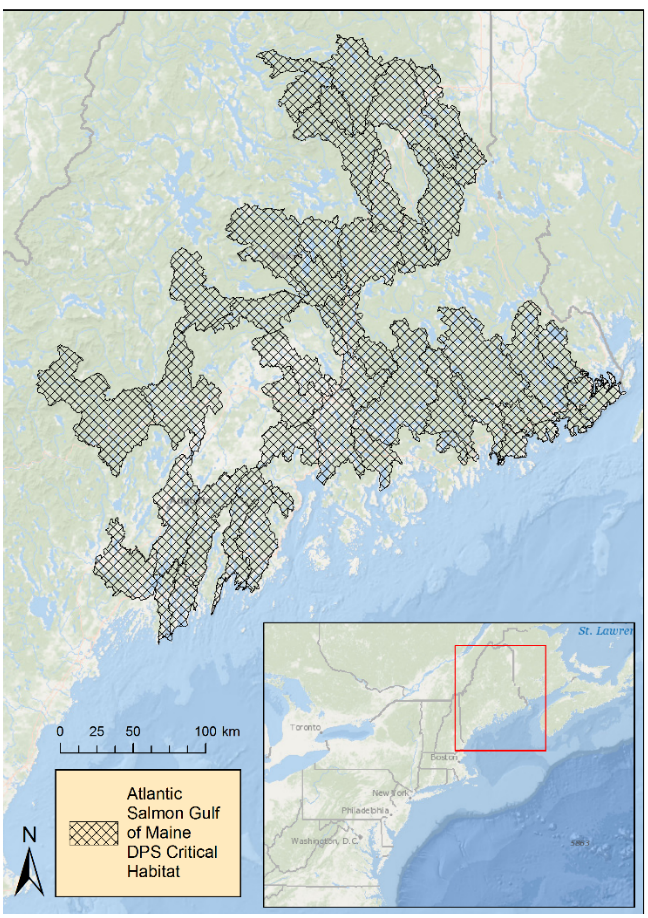

Figure 3. Map of designated critical habitat for the endangered Gulf of Maine distinct population segment of Atlantic salmon.

The critical habitat designation for the GOM DPS includes 45 specific areas occupied by Atlantic salmon that comprise approximately 19,571 kilometers (12,160.9 miles) of perennial river, stream, and estuary habitat and 799 square kilometers (308.5 square miles) of lake habitat within the range of the GOM DPS and on which are found those physical and biological features essential to the conservation of the species. Within the occupied range of the GOM DPS of Atlantic salmon 1,256 kilometers (780.4 miles) of river, stream, and estuary habitat and 100 square kilometers (38.6 square miles) of lake habitat have been excluded from critical habitat pursuant to section 4(b)(2) of the ESA.

6.3.2 Atlantic Sturgeon Critical Habitat

In 2017, NMFS designated critical habitat for all five DPSs (Carolina, Chesapeake, GOM, NYB, and South Atlantic) of Atlantic sturgeon in 31 rivers from Maine through Florida (Figure 4). The essential physical or biological features identified for Atlantic sturgeon critical habitat pertain to the features that promote larval, juvenile, and sub-adult growth and development, foraging habitat, water conditions suitable for adult spawning, and an absence of physical barriers (e.g., dams) (Table 3)

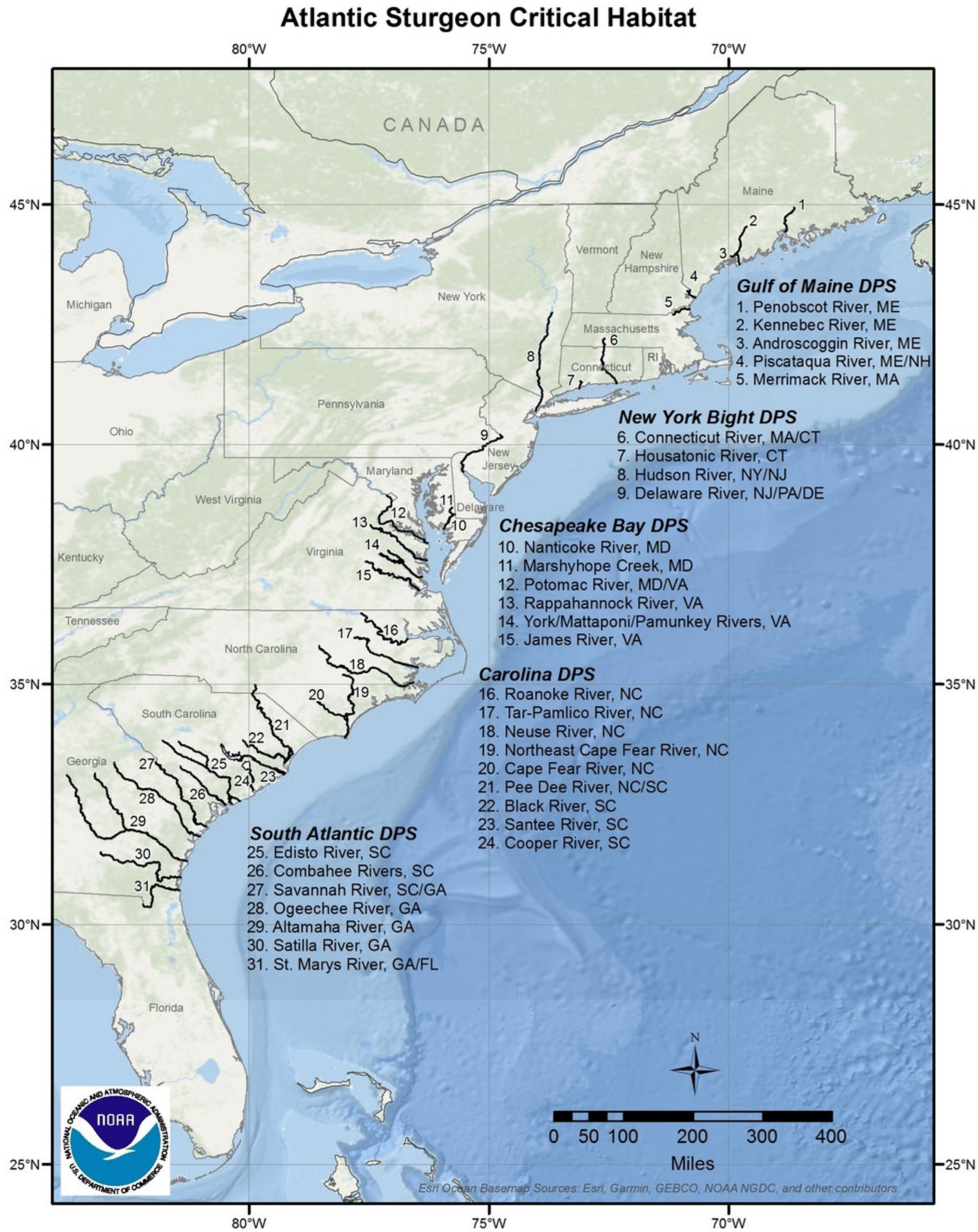

Figure 4. Map of designated critical habitat from Maine to Florida for threatened or endangered Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic distinct population segments of Atlantic sturgeon.

The essential physical and biological features identified for designated critical habitat for Atlantic sturgeon pertain to the features that promote larval, juvenile, and subadult growth and development, foraging habitat, water conditions suitable for adult spawning, and an absence of physical barriers (e.g., dams).

Table 3. Essential physical and biological features from Maine to Florida for five distinct population segments of Atlantic sturgeon.

Atlantic Sturgeon Distinct Population Segment	Physical or Biological Features
Gulf of Maine New York Bight Chesapeake Bay	Hard bottom substrate (e.g. rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages.
Gulf of Maine New York Bight Chesapeake Bay	Aquatic habitat with a gradual downstream salinity gradient of 0.5 to 30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development.
Gulf of Maine New York Bight Chesapeake Bay	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 main river channels must also be deep enough (e.g., greater than or equal to 1.2 meters [3.94 feet]) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
Gulf of Maine New York Bight Chesapeake Bay	Water, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: 1. Spawning; 2. Annual and interannual adult, subadult, larval, and juvenile survival; and

	3. Larval, juvenile, and subadult growth, development, and recruitment (e.g., 13º Celsius to 26º Celsius for spawning habitat and no more than 30º Celsius for juvenile rearing habitat, and 6 mg/L dissolved oxygen for juvenile rearing habitat).
Carolina South Atlantic	Suitable hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 ppt range) for settlement of fertilized eggs and refuge, growth, and development of early life stages.
Carolina South Atlantic	Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5 to 30 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development.
Carolina South Atlantic	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 and spawning condition adults. Water depths in main river channels must be deep enough to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. Water depths of at least 1.2 meters (3.94 feet) are generally deep enough to facilitate effective adult migration and spawning behavior.
Carolina South Atlantic	Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: 1. Spawning; 2. Annual and inter-annual adult, subadult, larval, and juvenile survival; and 3. Larval, juvenile, and subadult growth, development, and recruitment.

	Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L dissolved oxygen for juvenile rearing habitat is considered optimal, whereas dissolved oxygen less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25º Celsius. In temperatures greater than 26º Celsius, dissolved oxygen greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13º Celsius to 26º Celsius for spawning habitat are considered optimal.

ppt=parts per thousand, mg=milligram, L=liter

6.3.3 Potential Stressors to Endangered Species Act-Listed Critical Habitat

Potential stressors that are not likely to adversely affect ESA-listed designated critical habitat include pollution, vessel strike, vessel noise, and electrofishing.

6.3.3.1 Pollution

We find the possibility for oil or fuel leakage to be extremely unlikely to occur. Therefore, we conclude that pollution by oil or fuel leakage is not likely to adversely designated critical habitat.

6.3.3.2 Vessel Strike

While operation of the research vessel can result in minor changes in water flow, turbidity, and movement, these will be extremely local and temporary and thus not meaningful on a scale that would be expected to adversely affect critical habitat. Research vessels can come into close proximity with, or even in contact with, prey of ESA-listed species found within these critical habitats. We expect that any such interactions will only result in a slight displacement of prey. Fish are able to use a combination of sensory cues to detect approaching vessels, such as sight, hearing, and their lateral line (for nearby changes in water motion). Prey species are not generally considered vulnerable to vessel strike as they are considered faster moving and do not occur regularly at the water's surface. If larger prey were to come into contact with the research vessel's propellers, it is possible that individual prey can be killed. However, even if this unlikely event were to occur, the removal of several individual prey will have an immeasurable impact on the overall abundance of prey in these designated critical habitat areas. Given the short-term nature of the research vessel, they will not restrict inter-area passage.

Vessel presence may also cause a slight change in distribution of prey due to behavior or physical disturbance. Prey species may exhibit a temporary behavioral response to oncoming vessels and regardless of the response, there is the potential for some type of stress or enegetic cost as an individual fish must stop its current activity and divert its physiological and cognitive attention to responding to the vessel (Heffman et al. 2009). Behavioral avoidance and associated stress responses from detection of research vessels is not expected to result in impacts to the quantity, quality, or availability of prey species. These effects will be highly localized, occurring only within close proximity to the transiting research vessel, and temporary, with habitat conditions quickly returning to pre-exposure values once the research vessel leaves the action area. Given the localized and short-term nature of operation of research vessels in critical habitat, it is expected to have an insignificant effect on the physical and biological features of designated critical habitats.

The research vessel may cause minor changes to water flow, but will not significantly alter the physical conditions within the action area. The physical transit of the research vessel may result in brief obstruction of surface waters due to the presence of a research vessel and slight changes in dissolved oxygen levels, water temperature, and currents due to the research vessels displacement and mixing of water, but is not expected to have any effects on contaminant levels, depth, benthic habitat, and wake in rivers.

Therefore, we conclude that the the proposed action is not likely to adversely affect Atlantic salmon GOM DPS or Atlantic sturgeon designated critical habitat.

6.3.3.3 Vessel Noise

Given the short-term nature of the use of the research vessel in the action area, ambient noise levels will not be significantly altered. Vessel noise will occur, but will be short-term, minimal, diluted, and will not have any measurable impact on the PBFs of designated critical habitat for Atlantic salmon (GOM DPS) or Atlantic sturgeon.

Because the potential acoustic interference from engine noise is expected to be nearly undetectable or so minor that it cannot be meaningfully evaluated, we find that the risk from this potential stressor on designated critical habitat is insignificant. Therefore, we conclude that vessel noise may affect, but is not likely to adversely affect designated critical habitat.

6.3.3.4 Electrofishing

Electrofishing will not result in a migration barrier as it will only affect a small portion of the river at any given time. Because the research vessel has a small effective range, electric current, which could deter fish from passing through the affected area, will be experienced in an extremely small area of the river at any given time. Due to the limited range of the samping gear, there is always a sufficient zone of passage past the electrofishing for any Atlantic salmon, Atlantic sturgeon, or shortnose sturgeon moving past the area being sampled.

The proposed action will not alter the habitat in any way that will increase the risk of predation because the proposed action will not interfere with the natural functioning of any Atlantic salmon or Atlantic sturgeon habitat, nor will the proposed action have any long-term effect on the ability to detect and avoid any potential predators. Any effects to the water column will be limited to temporary electrification; there will be no other water quality impacts of the proposed action. The types of species that will be stunned by electrofishing gear and be subject to capture by the researchers (e.g., smallmouth bass [*Micropterus dolomieu*], white sucker [*Catostomus commersonii*], and American eel [*Anguilla rostrata*]) are not likely to be the same species that juvenile or adult Atlantic salmon or Atlantic sturgeon forage on (e.g., macroinvertebrates, rainbow smelt [*Osmerus mordax*], and sea lamprey [*Petromyzon marinus*]); thefore, the proposed action will not significantly affect the forage of juvenile or adult Atlantic salmon or Atlantic sturgeon.

Electrofishing will not affect the natural structure of the nearshore habitat, there will be no reduction in the capacity of substrate, food resources, or natural cover to meet the conservation needs of GOM DPS of Atlantic salmon and GOM DPS and NYB DPS of Atlantic sturgeon. Based upon this reasoning, we find that this stressor will have temporary short-term effects on designated critical habitat in the action area, but these will be insignificant. Therefore, we conclude the electrofishing may affect, but is not likely to adversely affect Atlantic sturgeon or Atlantic salmon designated critical habitat. Electrofishing may result in adverse effects to Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon, which are discussed further in this opinion.

Table 4. Summary table of stressor effects on Endangered Species Act-listed species and designated critical habitat in the action area.

Endangered Species Act-listed Species and Critical Habitat in the Action Area	Overall Determination	Potential Stressors			
		Pollution	Vessel Strike	Vessel Noise	Electrofishing
Fish					
Atlantic Salmon – Gulf of Maine DPS	LAA	NLAA	NLAA	NLAA	LAA
Atlantic Sturgeon – Gulf of Maine DPS	LAA	NLAA	NLAA	NLAA	LAA
Atlantic Sturgeon – New York Bight DPS	LAA	NLAA	NLAA	NLAA	LAA
Shortnose Sturgeon	LAA	NLAA	NLAA	NLAA	LAA
Designated Critical Habitat					
Atlantic Salmon – Gulf of Maine DPS	NLAA	NLAA	NLAA	NLAA	NLAA
Atlantic Sturegon – Gulf of Maine DPS	NLAA	NLAA	NLAA	NLAA	NLAA
Atlantic Sturgeon – New York Bight DPS	NLAA	NLAA	NLAA	NLAA	NLAA

DPS=Distinct Population Segment, LAA=Likely to Adversely Affect, NLAA=Not Likely to Adversely Affect

The only potential stressor that is likely to adversely affect ESA-listed species within the action area is electrofishing. This stressor associated with the proposed action may adversely affect the ESA-listed fish and are further analyzed and evaluated in detail in Section 9.

7 STATUS OF SPECIES LIKELY TO BE ADVERSELY AFFECTED BY THE PROPOSED ACTION

This opinion examines the status of each species that may be adversely affected by the proposed action. The evaluation of adverse effects in this opinion begins by summarizing the biology and ecology of those species that are likely to be adversely affected and what is known about their life histories in the action area. The status is determined by the level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and ESA-listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §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 published in the Federal Register, status reviews, recovery plans, and on the NMFS website: https://www.fisheries.noaa.gov/species-directory/threatened-endangered.

7.1 Atlantic Salmon – Gulf of Maine Distinct Population Segment

The Atlantic salmon is an anadromous fish, occupying freshwater streams in North America. There are three DPSs of Atlantic salmon in the United States (U.S.): Long Island Sound, Central New England, and the GOM (Fay et al. 2006). The GOM DPS of Atlantic salmon are found in watersheds throughout Maine (Figure 5).

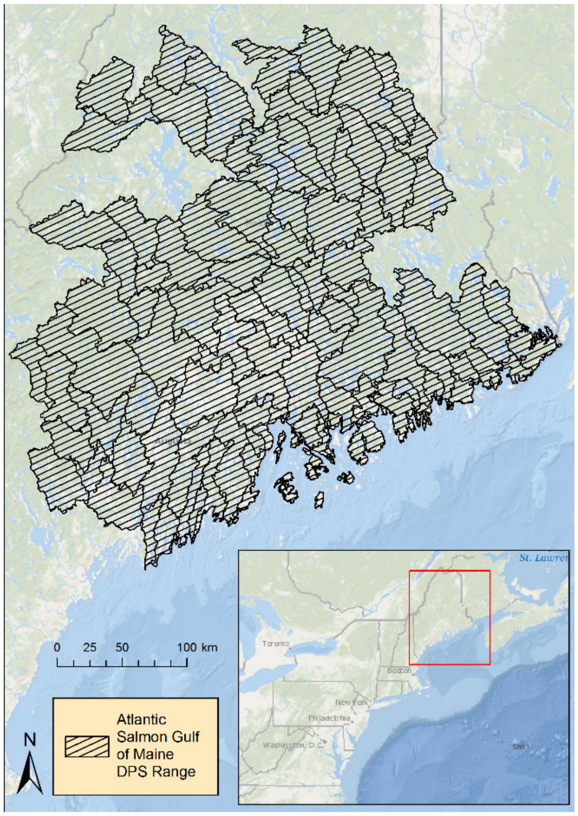

Figure 5. Map identifying the range of the endangerd Gulf of Maine distinct population segment of Atlantic salmon.

Adult Atlantic salmon are silver-blue with dark spots. 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 (74 FR 29344) 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.

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.

7.1.1 Life History

Adult Atlantic salmon typically spawn in early November and juveniles spend about two years in freshwater until they weigh approximately 0.06 kilograms (two ounces) and are 15.2 centimbers (six inches) in length. Smoltification (they physiological and behavioral changes required for the transition to salt water) usually occurs at age two for GOM DPS of Atlantic salmon. GOM DPS of Atlantic salmon migrate more than 4,000 kilometers (2,159.8 nautical miles) in the open ocean to reach feeding areas in the Davis Strait between Labrador and Greenland. The majority of GOM DPS of Atlantic salmon (about 90 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 of Atlantic salmon typically weigh between 3.6 to 6.8 kilograms (eight to 15 pounds) and average 76.2 centimeters (30 inches) in length.

7.1.2 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 GOM DPS of Atlantic salmon.

The conservation hatchery program plays a significant role in the persistence of GOM DPS of Atlantic salmon. In 2015, 4,000,000 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 returns to U.S. rivers was 921, and the majority (80 percent) of the adult returns 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 depressions, and outbreeding depression (Fay et al. 2006).

Adult returns of GOM DPS of Atlantic salmon captured six Maine rivers from 1997 through 2004 ranged from 567 to 1,402. These counts include both wild and hatchery origin fish. Each year, the majority (92 to 98 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).

There is no population growth rate available for GOM DPS of Atlantic salmon. However, the consensus is that the DPS exhibits a continuing declining trend (NOAA 2016).

The GOM DPS of Atlantic salmon is genetically distinct from other Atlantic salmon populations in Canada, and can be further delineated into stocks by river. The Downeast Coastal stocks include Dennys, East Machias, Machias, Pleasant, and Narraguagus rivers. The Penobscot Bay stock and the Merrymeeting Bay (Sheepscot). The hatchery supplementation programs for the Penobscote and Merrymeeting Bays stocks river-specific broodstock (USASAC 2016).

Animals from the GOM DPS of 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.

7.1.3 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 U.S., 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 Atlantic salmon from the GOM DPS. The GOM DPS of 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 to adult Atlantic salmon to the GOM DPS rivers remain extremely low, with an estimated extinction risk of 19 to 75 percent in the next 100 years (Fay et al. 2006). Based on the information above, the species would likely have a low resilience to additional perturbations.

7.1.4 Status in the Action Area

The abundance of GOM DPS of Atlantic salmon has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (approximately three percent over the last ten years) but appears stable. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels. However, stocking of hatchery products has not contributed to an increase in the overall abundance of Atlantic salmon and as yet has not been able to increase the naturally-reared component of the GOM DPS. Continued reliance on the conservation hatchery program could prevent extinction in the short term, but recovery of the GOM DPS of Atlantic salmon must be accomplished through increases in naturally-reared Atlantic salmon.

The Kennebec River watershed supports a small run of GOM DPS of Atlantic salmon. Restoration efforts in the watershed have utilized egg, fry, and parr stocking to promote returning adult Atlantic salmon. As such, all life stages of Atlantic salmon could be present in the action area of this consultation.

In 2019, there were a total of 1,535 Atlantic salmon to rivers in the U.S.. Almost all of the returning indivdiuals (1,528 out of 1,535 [99.5 percent]) were to the GOM DPS of Atlantic salmon. Most of the returns (75.7 percent) were of hatchery smolt origin and the others (24.3 percent) originated from either natural reproduction, stocked parr, hatchery fry, or eggs.

7.1.4.1 Adult Atlantic Salmon

Counts for Atlantic salmon in the Kennebec River are available since 2006, when a fish lift was installed at the first dam in the river (Lockwood Dam) (NMFS and USFWS 2009). Adult Atlantic salmon are trapped, and biological data (e.g., fork lengths) are collected before the individuals are trucked and rereleased in the Sandy River, which is an upstream tributary of the Kennebec River containing plentiful spawning and rearing habitat (MEDMR 2011). Returning adult Atlantic salmon at this first dam on the Kennebec River averaged just under eight fish per year from 1975 through 2000 and nearly 26 fish per year from 2006 through 2011. From 2015 through 2019, an average of 36 adult Atlantic salmon returned to the Kennebec River from trap counts and redd surveys.

In 2019, 60 adult (56 at a fish left and four captured) Atlantic salmon returned to the Kennebec River and were counted at he Lockwood Dam. Of the 60 returning Atlantic salmon, 55 individuals (91.7 percent) were two sea winter (2SW), six individuals (ten percent) were one sea winter (1SW) (i.e., grilse or a salmon that has returned to freshwater after a single winter at sea), and one inviduals (1.7 percent) was a long absence repeat spawner. Two indviduals were of hatchery origin and 58 individuals were naturally reared (i.e., wild) in origin. No Atlantic salmon were captured at the Benton Falls fish lift facility on the Sebasticook River in 2019.

Table 5. Estimated Atlantic salmon returns to the Kennebec River.

Year	Hatchery Origin				Wild Origin				Total
	1SW	2SW	3SW	Repeat	1SW	2SW	3SW	Repeat	
1975 – 2009	24	231	6	7	6	27	0	0	301
2010	0	2	0	0	1	2	0	0	5
2011	0	21	0	0	2	41	0	0	64
2012	0	1	0	0	0	4	0	0	5
2013	0	1	0	0	0	7	0	0	8
2014	0	2	0	0	3	13	0	0	18
2015	0	2	0	0	3	26	0	0	31
2016	0	0	0	0	1	38	0	0	39
2017	0	0	0	0	3	35	2	0	40
2018	0	1	0	0	3	7	0	0	11
2019	2	1	0	0	4	52	0	1	60
Total	26	262	6	7	26	252	2	2	582

1SW=One Sea Winter, 2SW=Two Sea Winter, 3SW=Three Sea Winter
Source: (USASAC 2020)

Table 6. Number of Gulf of Maine distinct population segment of Atlantic salmon counts at the Lockwood Dam on the Kennebec River from 2009 through 2019.

Year	Number of Atlantic Salmon
2009	33
2010	5
2011	64
2012	5
2013	8

2014	18
2015	31
2016	39
2017	40
2018	11
2019	56

Source: https://www.maine.gov/dmr/science-research/searun/programs/documents/trapcounts.pdf

Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea or overwinter in freshwater habitat and migrate in the spring, typically April or May (Baum 1997). Spring flows resulting in spillage at the dams facilitate out-migration of adult salmon (Shepard 1998). The number of kelts in the Kennebec River is proportional to the number of adults entering the river each year to spawn.

7.1.4.2 Juvenile Atlantic Salmon

The Kennebec River serves as migration habitat for adults returning to freshwater to spawn and for smolts and kelts departing to the ocean. Little to no suitable spawning or rearing habitat occurs in the mainstem Kennebec River in the vicinity of the proposed action area. Thus, fry or parr will not be expected to occur in the action area.

Generally, Atlantic salmon smolts begin moving out of Maine rivers in mid-April through June.The majority of the smolt migration appears to take place over a three to five week period after water temperatures rise to ten degrees Celsius.

Two federal hatcheries and two private hatcheries have been involved in stocking activities within the GOM DPS of Atlantic salmon, which has released 4,188,000 juveniles (eyed eggs, fry, parr, and smolts). In the Kennebec River, approximately 918,000 juveniles (egg eyed) have been released in 2019. Since 2001, a total of 8,433,009 juveniles (egg eyed, fry, parr, and smolt) have been released in the Kennebec River. While the annual abundance of smolts in the Kennebec River is presently unknown, MEDMR estimates the current egg stocking and natural reproduction in the Sandy River may be producing over 10,000 smolts annually. Smolt abundance in the Kennebec River is likely to remain stable or grow as restoration efforts in the Kennebec River continue.

7.1.5 Critical Habitat

Critical habitat has been designated for the GOM DPS of Atlantic salmon and was previously discussed in Section 6.3.1.

7.1.6 Recovery Goals

See the 2016 Draft Recovery Plan for the GOM DPS of Atlantic salmon, for complete downlisting/delisting criteria for each of their respective recovery goals. The following items were the top recovery actions identified to support in the Draft Recovery Plan:

1. Enhance connectivity between the ocean and freshwater habitats important for salmon recovery.
2. Maintain the genetic diversity of Atlantic salmon populations over time.
3. Increase adult spawners through the conservation hatchery program.
4. Increase adult spawners through the freshwater production of smolts.
5. Increase Atlantic salmon survival through increased ecosystem understanding and identification of spatial and temporal constraints to salmon marine productivity to inform and support management actios that improve survival.
6. Consult with all Tribes on a government-to-government basis.
7. Collaborate with partners and engage interested parties in recovery efforts for the GOM DPS.

7.2 Atlantic Sturgeon – Gulf of Maine Distinct Population Segment

Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004). The natal river systems of the GOM DPS of Atlantic sturgeon span from the Penobscot River south to Merrimack River (Figure 6).

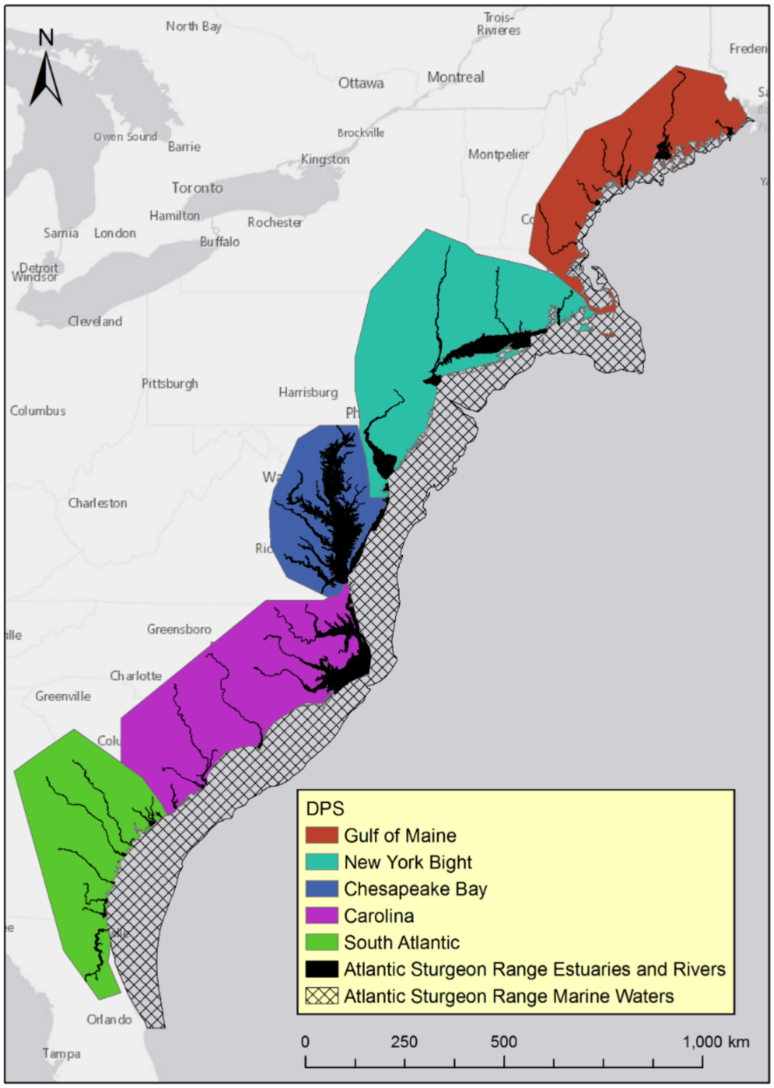

Figure 6. Map of geographic range and designated critical habitat for threatened or endangered Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic distinct population segments of Atlantic sturgeon.

The Atlantic sturgeon is a long lived, late maturing, subtropical, anadromous species. Atlantic sturgeon attain lengths of up to approximately 4.3 meters (14 feet), and weights of more than 36.9 kilograms (800 pounds). They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). The GOM DPS of Atlantic sturgeon was listed as threatened under the ESA on February 6, 2012 (77 FR 5880). The NYB DPS of Atlantic Sturgeon is discussed below in Section 7.3.

7.2.1 Life History

Atlantic sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Saint Lawrence River at 22 to 34 years (Scott and Crossman 1973). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in May through July in Canadian systems (Bain 1997; Caron et al. 2002; Murawski and Pacheco 1977; Smith 1985; Smith and Clugston 1997). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of 11 to 27 meters (36.1 to 88.6 feet) (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from one to five years for males (Caron et al. 2002; Collins et al. 2000; Smith 1985) and two to five years for females (Stevenson and Secor 2000; Van Eenennaam et al. 1996; Vladykov and Greeley 1963).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Scott and Crossman 1973). Following spawning, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94 to 140 hours after egg deposition at temperatures of 20 degrees and 18 degrees Celsius, respectively (Theodore et al. 1980). The yolksac larval stage is completed in about eight to 12 days, during which time larvae move downstream to rearing grounds over a six to 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from zero up to ten parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend at least two years and sometimes as many as five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985).

Upon reaching the subadult phase (approximately 76 to 92 centimeters [29.9 to 36.2 inches]), individuals may move to coastal and estuarine habitats (Dovel and Berggren 1983; Murawski and Pacheco 1977; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult (greater than 150 centimeters [59.1 inches] total length) Atlantic sturgeon may travel widely once they emigrate from rivers. These migratory subadults, as well as adult sturgeon, are normally captured in shallow (10 to 50 meters [32.8 to 164 feet]) near shore areas dominated by gravel and sand substrate (Stein et al. 2004). Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002). Because of high natal river fidelity, it appears that most rivers support independent populations (Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, and amphipods, mollusks, insects, and chironomids (Guilbard et al. 2007; Johnson et al. 1997; Moser and Ross 1995b; Savoy 2007).

7.2.2 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 GOM DPS of Atlantic sturgeon.

Historically, the GOM DPS of Atlantic sturgeon likely supported more than 10,000 spawning adults (ASSRT 2007; MSPO 1993; Secor 2002), suggesting the recent estimate of spawning adults within the GOM DPS is one to two orders of magnitude smaller than historical levels (i.e., hundreds to low thousands) (ASSRT 2007; Kahnle 2007).

There are some positive signs for the GOM DPS of Atlantic sturgeon, which include observations of Atlantic sturgeon in rivers for which sturgeon obserations have not been reported for many years (Saco, Presumpscot, and Charles rivers) and potentially higher catch-per-unit-effort levels than in the past (Kennebec River) (ASSRT 2007). These observations suggest that the abundance of the GOM DPS of Atlantic sturgeon is large enough that recolonization to rivers historically suitable for spawning may be occurring. Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

The GOM DPS of Atlantic sturgeon includes all Atlantic sturgeons that are spawned in the watershed from the Maine/Canada border and, extending southward, all watersheds draining into the GOM as far south as Chatham, Massachusetts. 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. Spawning still occurs in the Kennebec and Androscoggin rivers, and may occur in the Penobscot River. Atlantic sturgeon have more recently been observed in the Saco, Presumpscot, and Charles rivers.

7.2.3 Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870's through the mid-1990's. The fishery collapsed in 1901 and landings remained at between one to five present of the pre-collapse peak until Atlantic States Marine Fisheries Commission (ASMFC) placed a two generation moratorium on the fishery in 1998 (ASMFC 1998). The majority of the populations shows no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low dissolved oxygen can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for the continued existence of any of the DPSs.

7.2.4 Status in the Action Area

Spawning by the GOM DPS of Atlantic sturgeon occurs at discrete sites in the Kennebec River approximately 16.1 kilometers (10 miles) downstream of the proposed action area, but not in the approximately 24.1 kilometers (15 miles) reach that comprises the proposed action area. There are indications of increasing abundance of Atlantic sturgeon in the Kennebec River belonging to the GOM DPS of Atlantic sturgeon as shown by the recent increase in detections by in-river telemetry arrays and by encounters with MBI's electrofishing gear. These observations suggest that abundance of the GOM DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for the GOM DPS of Atlantic sturgeon.

7.2.5 Critical Habitat

Critical habitat has been designated for the GOM DPS of Atlantic sturgeon and was previously discussed in Section 6.3.2.

7.2.6 Recovery Goals

Recovery Plans have not yet been drafted for the Atlantic sturgeon.

7.3 Atlantic Sturgeon – New York Bight Distinct Population Segment

Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004). The natal river systems of the NYB DPS of Atlantic sturgeon span from the Connecticut River south to Delaware River (Figure 6). The NYB DPS of Atlantic sturgeon was listed as endangered under the ESA on February 6, 2012 (77 FR 5880).

7.3.1 Life History

Atlantic sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Hudson River at 11 to 21 years (Young et al. 1988). More information on the life history of Atlantic sturgeon is discussed above in Section 7.2.1.

7.3.2 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 NYB DPS of Atlantic sturgeon.

The NYB DPS of Atlantic sturgeon, which ranges from the Delmarva Peninsula to Cape Cod, historically supported four or more spawning populations. Currently, the NYB DPS of Atlantic sturgeon supports two spawning populations, the Delaware and Hudson rivers. Numbers of Atlantic sturgeon in the NYB DPS are extremely low compared to historical levels and have remained so for the past 100 years. The spawning population of the NYB DPS is thought to be one or two orders of magnitude below historical levels.

Population estimates based on mark and recapture of juvenile Atlantic sturgeon and voluntary logbook reporting indicate that the Delaware population has been declining rapidly over the last 20 years. Based on commercial fishery landings from the mid-1980s to mid-1990s, the total abundance of adult Atlantic sturgeon in the Hudson River was estimated at 870 individuals (Kahnle 2007). Based on the juvenile assessments from Peterson et al. (2000), the Hudson River suffered a series of recruitment failures, which triggered the ASMFC fishing moratorium to allow the populations to recover. Long-term juvenile surveys indicate that the Hudson River population supported successful annual year classes since 2000 and the annual production has been stable and/or slightly increasing in abundance (ASSRT 2007). Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

Recently, juvenile Atlantic sturgeon collected in the Connecticut River suggest at least one successful colonizing spawning event may have occurred (Savoy et al. 2017). Around the same time, a dead 213 centimeter (83.9 inches) Atlantic sturgeon was recovered on the banks of the Connecticut River (http://www.wfsb.com/story/25392783/rare-sturgeon-found-along-connecticut-riverin-lyme).

The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

The natal river systems of the NYB DPS of Atlantic sturgeon span from the Connecticut River south to the Delaware River (Figure 6). The Connecticut River has long been known as a seasonal aggregation area for subadult Atlantic sturgeon, and both historical and contemporary records document presence of Atlantic sturgeon in the river as far upstream as Hadley, Massachusetts (Everly and Boreman 1999; Pacileo 2003; Savoy and Shake 1992). The upstream limit for Atlantic sturgeon on the Hudson River is the Federal Dam at the fall line, approximately river kilometer 246 (Bain 1997; Dovel and Berggren 1983; Everly and Boreman 1999; Kahnle et al. 1998). In the Delaware River, there is evidence of Atlantic sturgeon presence from the mouth of the Delaware Bay to the head-of-tide at the fall line near Trenton on the New Jersey side and Morrisville on the Pennsylvania side of the river, a distance of 220 river kilometers (Breece et al. 2013).

7.3.3 Status

More information on the status of Atlantic sturgeon is discussed above in Section 7.2.3

7.3.4 Status in the Action Area

There are no current, published population abundance estimates for any of the currently known spawning stocks. Therefore, there are no published abundance estimates for any of the five DPSs of Atlantic sturgeon. Population estimates for the GOM and NYB DPSs of Atlantic sturgeon were reported by Kocik et al. (2013) to be 15,393 and 68,568 individuals, respectively. Only a small proportion (less than six percent) of Atlantic sturgeon encountered in the GOM could be expected to have originated from the NYB DPS of Atlantic sturgeon (Damon-Randall et al. 2010). Considering this, the number of Atlantic sturgeon in the Kennebec River proposed action area that may have originated from the NYB DPS of Atlantic sturgeon is extremely low.

Atlantic sturgeon continue to be threatened by the persistence of degraded water quality, vessel strikes, and habitat modification. Additional threats that the Newy York Bight DPS of Atlantic sturgeon may encounter in the proposed action area are migratory barriers (dams), and the artificial stream flow associated with the retention and episodic release of impounded water from large hydroelectric dams.

7.3.5 Critical Habitat

Critical habitat has been designated for the NYB DPS of Atlantic sturgeon and was previously discussed in Section 6.3.2.

7.3.6 Recovery Goals

Recovery Plans have not yet been drafted for the Atlantic sturgeon.

7.4 Shortnose Sturgeon

Shortnose sturgeon occur in estuaries and rivers along the east coast of North America (Vladykov and Greeley 1963). Their northerly distribution extends to the Saint John River, New Brunswick, Canada, and their southerly distribution historically extended to the Indian River, Florida (Evermann and Bean 1898; Scott and Scott 1988) (Figure 7).

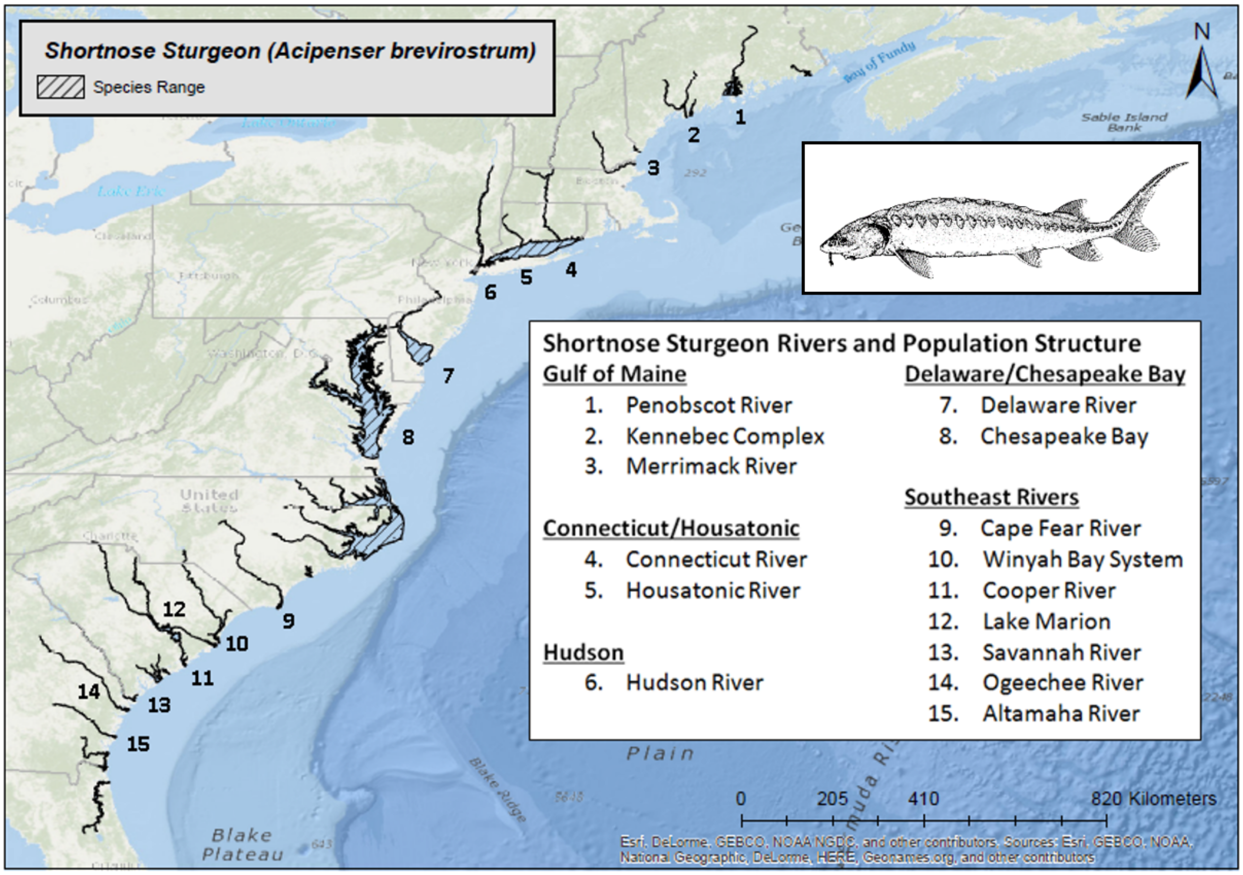

Figure 7. Map of geographic range of the endangered shortnose sturgeon.

The shortnose sturgeon is the smallest of the three sturgeon species that occur in eastern North America. It has an benthic fusiform body and its head and snout are smaller while its mouth is larger relative to Atlantic sturgeon (Dadswell 1984). Shortnose sturgeon vary in color but are generally dark brown to olive/black on the dorsal surface, lighter along the row of lateral scutes and nearly white on the ventral surface (Gilbert 1989). The shortnose sturgeon was listed as endangered under the Endangered Species Preservation Act of 1966 on March 11, 1967 (32 FR 4001). Shortnose sturgeon remained on the endangered species list with the enactment of the ESA in 1973 (38 FR 41370).

7.4.1 Life History

Shortnose sturgeon are relatively slow growing, late maturing and long-lived. Growth rate, maximum age, and maximum size vary with latitude; populations in southern areas grow more rapidly and mature at younger ages but attain smaller maximum sizes that those in the north (Dadswell et al. 1984). In general, females reach sexual maturity in the south as early as age four and in the north as late as age 18, and males display similar differences in latitudinal development, maturing between ages two and 11 (NMFS 2010). Shortnose sturgeon overwinter in the lower portions of rivers and migrate upriver to spawn in the spring. Males spawn every other year while females spawn every three to five years (Dadswell 1979a; Kieffer and Kynard

1996). Spawning females deposit their eggs over gravel, rubble, and/or cobble often in the farthest accessible upstream reach of the river (Kynard 1997). After spawning, adult shortnose sturgeon move rapidly to downstream feeding areas where they forage on benthic insects, crustaceans, mollusks, and polychaetes (Buckley and Kynard 1985; Dadswell 1984; Kieffer and Kynard 1993; O'Herron et al. 1993).

Upon hatching, shortnose sturgeon shelter in dark substrate or are found in schools swimming against the current. Around four to 12 days after hatching individuals begin to feed exogenously and are dispersed downstream. These larvae are often found in the deepest water, usually within the channel (Kieffer and Kynard 1993; O'Connor et al. 1981; Parker and Kynard 2014; Taubert and Dadswell 1980). Young of the Year remain in freshwater habitats upstream of the salt wedge for about one year (Dadswell et al. 1984; Kynard 1997). The age at which juveniles begin to utilize habitat associated with the salt/fresh water interface varies with river system from age one to eight (Collins et al. 2002; Dadswell 1979a; Flournoy et al. 1992). Overwintering habitat and behavior of shortnose sturgeon varies with latitude: fish in northern rivers form tight aggregations with little movement and will inhabit either freshwater or saline reaches of the river, while fish in the south are more active and are found predominantly near the fresh/salt water interface (Collins and Smith 1993; Kynard et al. 2012; Weber et al. 1998).

The general pattern of coastal migration of shortnose sturgeon indicates movement between groups of rivers proximal to each other across the geographic range (Altenritter et al. 2015; Dionne et al. 2013; Quattro et al. 2002; Wirgin et al. 2005). However, migration/straying is not necessarily resulting in effective gene exchange as indicated by high degree of genetic differentiation among riverine populations. Based on genetic analyses, the shortnose sturgeon population has been grouped into five regional population clusters: GOM, Connecticut/Housatonic rivers, Hudson River, Delaware River/Chesapeake Bay, and Southeast. The shortnose sturgeon status review team recommends, however, that recovery and management actions consider each riverine population as a management/recovery unit (NMFS 2010).

7.4.2 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 shortnose sturgeon.

The 1998 Final Recovery Plan for shortnose sturgeon recommended that 19 separate river populations of shortnose sturgeon be managed as DPSs (NMFS 1998b). Upon further analysis, five regional population clusters of shortnose sturgeon have been determined (Table 7) for abundance estimates for populations within each of these population clusters.

Table 7. Shortnose sturgeon population and estimated abundances.

Regional Population Cluster	Location[1]	Abundance Estimate (Upper/Lower 95% CI)[2]	Source – Year of Data Collection
Gulf of Maine	Penobscot River Kennebec Complex Merrimack River	1,049 (673/6,939) 9,488 (6,942/13,358) 2,000 (NA)	(NMFS 2012) 2006-2007 (Squiers 2004) 1998-2000 (NMFS 2010) 2009
Connecticut and Housatonic Rivers	Connecticut River – Upper Connecticut River – Lower	143 (14/360) 1,297 (NA)	(Kynard et al. 2012) 1994-2001 (Savoy 2004) 1996-2002
Hudson River	Hudson River	30,311 (NA)	(NMFS 2010) 1980
Delaware River/Chesapeake Bay	Delaware River	12,047 (10,757/13,580)	(Brundage III 2006) 1999-2003
Southeast Rivers	Cape Fear River Winyah Bay System Cooper River Lake Marion Savannah River Ogeechee River Altamaha River	50 (NA) Unknown (NA) 301 (150/659) Unknown (NA) 2,000 (NA) 147 (104/249) 6,320 (4,387/9,249)	(NMFS 2010) NA (NMFS 2010) NA (Cooke et al. 2004) 1996-1998 (NMFS 2010) NA (NMFS 2010) NA (Fleming et al. 2003) 1999-2000 (DeVries 2006) 2004-2005

1=Locations listed here are those for which population estimates are available, and/or those in which spawning has been confirmed. Additional waterbodies which confirmed shortnose sturgeon include Piscataqua River, Housatonic River, Chesapeake Bay, Susquehana River, Potomac River, Roanoke River, Chowan River, Tar/Pamlico River, Neuse River, New River, North River, Santee River, ACE Basin, Santilla River, St. Mary's River, St. Johns River.
2=Abundance estimates are established using different techniques and should be viewed with caution. Estimates listed here are those identified by NMFS in the 2010 Biological Assessment of Shortnose Sturgeon (NMFS 2010).

Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

Genetic diversity estimates for shortnose sturgeon have been shown to be moderately high in both mitochondrial deoxyribonucleic acid (mtDNA) (Quattro et al. 2002; Wirgin et al. 2005; Wirgin et al. 2010) and nuclear deoxyribonucleic acid (nDNA) (King et al. 2013) genomes. The mtDNA and nDNA studies performed to date suggest that dispersal is a very important factor in maintaining these high levels of genetic diversity.

Shortnose sturgeon occur along the east coast of North America in rivers, estuaries, and the sea. They were once present in most major river systems along the coast of the Atlantic Ocean

(Kynard 1997). Their current distribution extends north to the Saint John River, New Brunswick, Canada, and south to the Saint Johns River, Florida (NMFS 1998b). Currently, the distribution of shortnose sturgeon across their range is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers (248.5 miles) near their geographic center in North Carolina and Virginia. Some river systems host populations which rarely leave freshwater while in other areas coastal migrations between river systems are common. Spawning locations have been identified within a number of river systems (NMFS 2010).

7.4.3 Status

The decline in abundance and slow recovery of shortnose sturgeon has been attributed to pollution, overfishing, bycatch in commercial fisheries, and an increase in industrial uses of the nation's large coastal rivers during the 20th century (e.g., hydropower, nuclear power, treated sewage disposal, dredging, construction) (NMFS 2010). In addition, the effects of climate change may adversely impact shortnose sturgeon by reducing the amount of available habitat, exacerbating existing water quality problems, and interfering with migration and spawning cues (NMFS 2010). Without substantial mitigation and management to improve access to historical habitats and water quality of these systems, shortnose sturgeon populations will likely continue to be depressed. This is particularly evident in some southern rivers that are suspected to no longer support reproducing populations of shortnose sturgeon (NMFS 2010). The number of river systems in which spawning has been confirmed has been reduced to around 12 locations (NMFS 2010).

7.4.4 Status in the Action Area

In 1999, the Edwards Dam at Augusta, Maine, which represented the first significant impediment to the upstream migration of shortnose sturgeon (and the downstream extent of the action area) in the Kennebec River, was removed. With the removal of the dam, approximately 27.4 kilometers (17 miles) of previously inaccessible sturgeon habitat north of Augusta was made available. In order to monitor the recolonization of the habitat above Edwards Dam, MEDMR conducted an ichthyoplankton survey from 1997 through 2001. Twelve sampling sites were established above the former dam site and 13 sites were established below the former dam site. While no shortnose sturgeon eggs or larvae were collected above the former dam site in 2000 or 2001 (Wippelhauser 2003), small numbers of eggs or larvae were collected at sites in the first 9 kilometers (5.6 miles) below the site. Tome Squiers (MEDMR) hypothesized that the major spawning area for shortnose sturgeon in the Kennebec River was likely located in the first 11 kilometers (6.8 miles) below the former Edwards Dam site. On May 11, 1999, 135 shortnose sturgeon were caught in the Kennebec River 10 kilometers (6.2 miles) below Edwards Dam and were assumed to be on the spawning run. The water temperature was 14 degrees Celsius.

Aside from the initial studies (1997 through 2001), no further research has been conducted to determine if shortnose sturgeon spawning activity occurred above the former Edwards Dam.

Other research activities for shortnose sturgeon conducted by University of Marine investigators were authorized through scientific research permits issued by NMFS through 2017. Several shortnose sturgeon have been captured incidental to other studies in Waterville (and some at the base of the Lockwood Dam) 27 kilometers (16.8 miles) above the former Edwards Dam since its removal. A Schnabel estimate using tagging and recapture data from 1998, 1999, and 2000 estimates a population of 9,488 (95% CI, 6,942 to 13,358) for the entire estuarine complex (Squires 2003). The average density of adult shortnose sturgeon per hectare of habitat in the estuarine complex of the Kennebec River was the second hightest of any population studied through 1983 (Dadswell 1984). Shortnose sturgeon occupy the Kennebec River year-round and migrate up and downstream seasonally between overwintering habitat, spawning grounds, and foraging areas.

The Lockwood Dam is located at the site of a natural falls (Ticonic Falls) in Waterville, and it delineates the upstream extent of the proposed action area. It is not believed that shortnose sturgeon will have been able to pass upstream of the falls, and Ticonic Falls is thought to be the natural upstream limit for shortnose sturgeon in the Kennebec River. The Schnabel estimate from 1998 through 2000 is the most recent population estimate for the Kennebec River shortnose sturgeon population; however, this estimate includes fish from the Androscoggin and Sheepscot rivers as well and does not include an estimate of the size of the juvenile population. A comparison of the population estimate for the estuarine complex from 1982 through 2000 (Squires 2003) suggests that the adult population has grown by approximately 30 percernt in the last 20 years. Based on this information, NMFS believes that the shortnose sturgeon population in the Kennebec River is increasing; however, without more information on the status of more recent year classes (i.e., juveniles) it is difficult to speculate about the long-term survival and recovery of this population.

As more suitable habitat becomes available as a result of dam removals and restoration projects, or as the existing in-river flow rates and thermal regime are gradually altered by climate change, spawning and overwintering areas may continue to change. However, based on the best available information on the seasonal distribution of shortnose sturgeon in the Kennebec River and the time and locations of the proposed sampling, adult shortnose sturgeon may be present in the action area as they descend the river toward overwintering sites.

7.4.5 Critical Habitat

No critical habitat has not been designated for the shortnose sturgeon.

7.4.6 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 populations to levels of abundance at which they no longer require protection under the ESA (NMFS 1998a). Each population may become a candidate for downlisting when it reaches a minimum population size that: (1) is large enough to prevent extinction; and (2) will make the loss of genetic diversity unlikely. The minimum population size for each population segment has not yet been determined (NMFS 1998b; NMFS 2010). 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.

8 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. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02).

8.1 Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Effects of climate change include sea level rise, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to impact ESA resources. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://climate.gov).

In order to evaluate the implications of different climate outcomes and associated impacts throughout the 21st century, many factors have to be considered. The amount of future greenhouse gas emissions is a key variable. Developments in technology, changes in energy generation and land use, global and regional economic circumstances, and population growth must also be considered.

A set of four scenarios was developed by the Intergovernmental Panel on Climate Change (IPCC) to ensure that starting conditions, historical data, and projections are employed consistently across the various branches of climate science. The scenarios are referred to as representative concentration pathways (RCPs), which capture a range of potential greenhouse gas emissions pathways and associated atmospheric concentration levels through 2100 (IPCC 2014). The RCP scenarios drive climate model projections for temperature, precipitation, sea level, and other variables: RCP2.6 is a stringent mitigation scenario; RCP2.5 and RCP6.0 are intermediate scenarios; and RCP8.5 is a scenario with no mitigation or reduction in the use of fossil fuels. The IPCC future global climate predictions (2014 and 2018) and national and regional climate predictions included in the Fourth National Climate Assessment for U.S. states and territories (2018) use the RCP scenarios.

The increase of global mean surface temperature change by 2100 is projected to be 0.3 to 1.7 degrees Celsius under RCP2.6, 1.1 to 2.6 degrees Celsius under RCP4.5, 1.4 to 3.1 degrees Celsius under RCP6.0, and 2.6 to 4.8 degrees Celsius under RCP8.5 with the Arctic region warming more rapidly than the global mean under all scenarios (IPCC 2014). The observed acceleration in carbon emissions over the last 15 to 20 years, even with a lower trend in 2016, has been consistent with higher future scenarios such as RCP8.5 (Hayhoe et al. 2018).

The globally-averaged combined land and ocean surface temperature data, as calculated by a linear trend, show a warming of approximately 1 degree Celsius from 1901 through 2016 (Hayhoe et al. 2018). The *IPCC Special Report on the Impacts of Global Warming* (2018) (IPCC 2018) noted that human-induced warming reached temperatures between 0.8 and 1.2 degrees Celsius above pre-industrial levels in 2017, likely increasing between 0.1 and 0.3 degrees Celsius per decade. Warming greater than the global average has already been experienced in many regions and seasons, with most land regions experiencing greater warming than over the ocean (IPCC 2018). Annual average temperatures have increased by 1.8 degrees Celsius across the contiguous U.S. since the beginning of the 20th century with Alaska warming faster than any other state and twice as fast as the global average since the mid-20th century (Jay et al. 2018). Global warming has led to more frequent heatwaves in most land regions and an increase in the frequency and duration of marine heatwaves (IPCC 2018). Average global warming up to 1.5 degrees Celsius as compared to pre-industrial levels is expected to lead to regional changes in extreme temperatures, and increases in the frequency and intensity of precipitation and drought (IPCC 2018).

Several of the most important threats contributing to the extinction risk of ESA-listed species, particularly those with a calcium carbonate skeleton such as corals and mollusks as well as species for which these animals serve as prey or habitat, are related to global climate change. The main concerns regarding impacts of global climate change on coral reefs and other calcium carbonate habitats generally, and on ESA-listed corals and mollusks in particular, are the magnitude and the rapid pace of change in greenhouse gas concentrations (e.g., carbon dioxide and methane) and atmospheric warming since the Industrial Revolution in the mid-19th century. These changes are increasing the warming of the global climate system and altering the carbonate chemistry of the ocean (ocean acidification (IPCC 2014)). As carbon dioxide concentrations increase in the atmosphere, more carbon dioxide is absorbed by the oceans, causing lower pH and reduced availability of calcium carbonate. Because of the increase in carbon dioxide and other greenhouse gases in the atmosphere since the Industrial Revolution, ocean acidification has already occurred throughout the world's oceans, including in the Caribbean Sea, and is predicted to increase considerably between now and 2100 (IPCC 2014).

The Atlantic Ocean appears to be warming faster than all other ocean basins except perhaps the southern oceans (Cheng et al. 2017). In the western North Atlantic Ocean surface temperatures have been unusually warm in recent years (Blunden and Arndt 2016). A study by Polyakov et al. (2009) suggests that the North Atlantic Ocean overall has been experiencing a general warming trend over the last 80 years of 0.031±0.0006 degrees Celsius per decade in the upper 2,000 meters (6,561.7 feet) of the ocean. Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney et al. 2012). Since the early 1980s, the annual minimum sea ice extent (observed in September each year) in the Arctic ocean has decreased at a rate of 11 to 16 percent per decade (Jay et al. 2018). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2014) and this rise has been linked to climate change. Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, tropical storms, heat waves, and droughts (IPCC 2014).

8.1.1 Climate Change in the Action Area

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Kennebec River watershed largely focus on effects that rising water levels may have on the human environment or landscape level changes (see University of Massachusetts Assessment of Landscape Changes). Available information is summarized in Jacobson et al. (2009), Fernandez et al. (2015), and Fernandez et al. (2020) (https://climatechange.umaine.edu/climate-matters/maines-climate-future/). This report indicates that for Maine, regional sea surface temperatures have increased almost 2.9 degrees Fahrenheit since 1895. The steepest temperature rise has occurred in recent decades, and "heatwaves" occurred in 2012 and 2016 (Pershing 2018), and the rate of sea level rise has intensified. Tide-gauge records in Portland, Maine, show a local relative sea-level rise of approximately 19 centimeters (7.5 inches) since 1912. Earlier snowmelt, peak river flows, and ice-out have been observed in Maine lakes. Models suggest that in the future, temperatures will be warmer and there will be more precipitation in all seasons. The effects of climate change will not increase appreciably during the proposed survey period. However, less snow may fall each winter and be replaced by rain. Additionally, increased rainfall will result in more runoff which in turn will likely reduce water quality in the action area.

Sea level rise could result in the northward movement of the salt wedge in the Kennebec River. Potential negative effects of a shift in the salt wedge include restricting the habitat available for early life stages and juvenile sturgeon, which are intolerant to salinity and are present exclusively upstream of the salt wedge. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shift that may occur.

As noted above, warming trends are evident. However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Kennebec River generally.

Sea surface temperatures have fluctuated around a mean for much of the past century, as measured by continuous 100+ year records at Woods Hole, Massachuetts and Boothbay Harbor, Maine and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing; for example, Boothbay Harbor's temperature has increased by about one degree Celsius since 1970. For marine waters, the model projections are for an increase of somewhere between three to four degrees Celsius by 2100 and a pH drop of 0.3 to 0.4 units by 2100 (Frumhoff et al. 2007). Assuming that these predictions also apply to the action area, one could anticipate similar conditions in the action area over that same time period; considering that the proposed action will occur until 2030, we could predict an increase in ambient water temperatures of 0.034 to 0.045 per year, for an overall increase of 0.24 to 0.32 degrees Celsius. As there is significant uncertainty in the rate and timing of change, as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose and Atlantic sturgeon and Atlantic salmon.

Over time, the most likely effect to Atlantic and shortnose sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north, which would restrict the range of juvenile sturgeon and may affect the development of these life stages. Upstream shifts in spawning or rearing habitat in the Kennebec River are limited by the existence of the Lockwood Dam, which is impassable by sturgeon. Similarly, the upstream movement of sturgeon is limited by the Brunswick Dam in the Androscoggin River. The available habitat for juvenile sturgeon could decrease over time; however, even if the salt wedge shifted several miles upstream, it seems unlikely that the decrease in available habitat would have a significant effect on juvenile sturgeon, because there would still be many miles of available low-salinity habitat between the salt wedge and the Lockwood or Brunswick dams.

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations through the area as sturgeon and salmon make seasonal movements. For sturgeon, there could be shifts in the timing of spawning; presumably, if water temperatures warm earlier in the spring, and water temperature is a primary spawning cue, spawning migrations and spawning events could occur earlier in the year. However, because spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of sturgeon through the action area. For salmon, there could be shifts in the timing of downstream movements by smolts or shifts in the timing of returns to the river by adults. However, during the ten-year time period considered here, major shifts in seasonal migrations due to climate change are unlikely, given the relatively slow rate of predicted climate change.

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon or salmon. If salmon or sturgeon distribution shifted along with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food. Similarly, if sturgeon shifted to areas where different forage was available and sturgeon were able to obtain sufficient nutrition from that new source of forage, any effect would be minimal. The greatest potential for effect to forage resources would be if salmon or sturgeon shifted to an area or time where insufficient forage was available. The likelihood of this happening seems low because salmon and sturgeon feed on a wide variety of species and in a wide variety of habitats.

Limited information on the thermal tolerances of Atlantic and shortnose sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30 degrees Celsius in the south (Damon-Randall et al. 2010); in the wild, shortnose sturgeon are typically found in waters less than 28 degrees Celsius (82.4 degrees Fahrenheit). In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28 degrees Celsius (82.4 degrees Fahrenheit) (Niklitschek 2001)). Tolerance to temperatures is thought to increase with age and body size (Jenkins et al. 1993; Ziegeweid et al. 2008), however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, have been documented in the lab to experience mortality at temperatures of 33.7 degrees Celsius (92.7 degrees Fahrenheit) or greater and are thought to experience stress at temperatures above 28 degrees Celsius (82.4 degrees Fahrenheit). For purposes of considering thermal tolerances, we consider Atlantic sturgeon to be a reasonable surrogate for shortnose sturgeon, given similar geographic distribution and known biological similarities.

Normal surface water temperatures in the Kennebec River can be as high as 25 degrees Celsius (77 degrees Fahrenheit) at some times and in some areas during the summer months; temperatures in deeper waters and near the bottom are cooler. A predicted increase in water temperature of 3 to 4 degrees Fahrenheit (within 100 years) is expected to result in temperatures approaching the preferred temperature of shortnose and Atlantic sturgeon (28 degrees Celsius; 82.4 degrees Fahrenheit) on more days and/or in larger areas. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters.

As described above, over the long term, global climate change may affect shortnose and Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature, and water quality. Atlantic salmon are likely to be affected not only by conditions in rivers but also oceanic conditions. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which shortnose or Atlantic sturgeon or Atlantic salmon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect listed species and their habitat within the action area. While we can make some predictions on the likely effects of climate change on these species, without modeling and additional scientific data, these predictions remain speculative. Additionally, these predictions do not take into account the adaptive capacity of these species which may allow them to deal with change better than predicted.

8.1.2 Effects on Atlantic Salmon

Atlantic salmon may be especially vulnerable to the effects of climate change in New England, because the areas surrounding many watersheds where salmon are found are heavily populated and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliott et al. 1998). Climate effects related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland 1998). One study conducted in the Connecticut and Penobscot rivers, where temperatures and average discharge rates have been increasing over the last 25 years, found that dates of first capture and median capture dates for Atlantic salmon have shifted earlier by about 0.5 days/ year, and these consistent shifts are correlated with long-term changes in temperature and flow(Juanes et al. 1998). Temperature increases are also expected to reduce the abundance of salmon returning to home waters, particularly at the southern limits of Atlantic salmon spatial distribution (Beaugrand and Reid 2003).

A study conducted in the United Kingdom that used data collected over a 20-year period in the Wye River found Atlantic salmon populations have declined substantially and this decline was best explained by climatic factors, like increasing summer temperatures and reduced discharge, more than any other factor (Clews et al. 2010). Changes in temperature and flow serve as cues for salmon to migrate, and smolts entering the ocean either too late or too early would then begin their post-smolt year in such a way that could be less optimal for opportunities to feed, predator risks, and/or thermal stress (Friedland 1998). Since the highest mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater et al. 2003).Temperature influences the length of egg incubation periods for salmonids (Elliott et al. 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

As sea level rises due to melting polar ice, the salt wedge in the river is expected to shift further upstream. Over the long term, this could change the habitat characteristics (e.g. salinity) of theaction area. Another potential impact of climate change is to the synchronization of naturally occurring biological events, known as phenology. For example, if adult salmon encounter riverine temperatures greater than 23 degrees Celsius, they are likely to abandon their upstream spawning migration which will result in depressed reproductive success rates. If the out migrating salmon smolt prey base is not immediately available in the lower Kennebec River due to climate change, juvenile salmon marine survival rates are likely to decline.

Because fish maintain a body temperature almost identical to their surroundings, thermal changes of a few degrees Celsius can critically affect biological functions in salmonids (NMFS and USFWS 2005). While some fish populations may benefit from an increase in river temperature for greater growth opportunity, there is an optimal temperature range and a limit for growth after which salmonids will stop feeding due to thermal stress (NMFS and USFWS 2005). Thermally-stressed salmon also may become more susceptible to mortality from disease (Clews et al. 2010). A study performed in New Brunswick found there is much individual variability between Atlantic salmon and their behaviors and noted that the body condition of fish may influence the temperature at which optimal growth and performance occur (Breau et al. 2007).

The productivity and feeding conditions in Atlantic salmon's overwintering regions in the ocean are critical in determining the final weight of individual salmon and whether they have sufficient energy to migrate upriver to spawn (Lehodey et al. 2006). Survival is inversely related to body size in pelagic fishes, and temperature has a direct effect on growth that will affect growth-related sources of mortality in post-smolts (Friedland 1998). Post-smolt growth increases in a linear trend with temperature, but eventually reaches a maximum rate and decreases at high temperatures (Friedland 1998). When at sea, Atlantic salmon eat crustaceans and small fishes, such as herring, sprat, sand-eels, capelin, and small gadids, and when in freshwater, adults do not feed, but juveniles eat aquatic insect larvae (FAO 2012). Species with calcium carbonate skeletons, such as the crustaceans that salmon sometimes eat, are particularly susceptible to ocean acidification, since ocean acidification will reduce the carbonate availability necessary for shell formation (Wood et al. 2008). Climate change is likely to affect the abundance, diversity, and composition of plankton, and these changes may have important consequences for higher trophic levels like Atlantic salmon (Beaugrand and Reid 2003).

In addition to temperature, stream flow is also likely to be impacted by climate change and is vital to Atlantic salmon survival. In-stream flow defines spatial relationships and habitat suitability for Atlantic salmon, and since climate change is likely to affect in-stream flow, the physiological, behavioral, and feeding-related mechanisms of Atlantic salmon are also likely to be impacted (Friedland 1998). With changes in in-stream flow, salmon found in smaller river systems may experience upstream migrations that are confined to a narrower timeframe, as small river systems tend to have lower discharges and more variable flow (Elliott et al. 1998). The changes in rainfall patterns expected from climate change and the impact of those rainfall patterns on flows in streams and rivers may severely impact productivity of salmon populations (Friedland 1998). More winter precipitation falling as rain instead of snow can lead to elevated winter peak flows which can scour the streambed and destroy salmon eggs (Battin et al. 2007; Elliott et al. 1998). Increased sea levels in combination with higher winter river flows could cause degradation of estuarine habitats through increased wave damage during storms (NSTC 2008). Since juvenile Atlantic salmon are known to select stream habitats with particular characteristics, changes in river flow may affect the availability and distribution of preferred habitats (Riley et al. 2009). Unfortunately, the critical point at which reductions in flow begin to have a damaging impact on juvenile salmonids is difficult to define, but generally, flow levels that promote upstream migration of adults are likely adequate to encourage downstream movement of smolts (Hendry et al. 2003).

Humans may also seek to adapt to climate change by manipulating water sources, for example in response to increased irrigation needs, which may further reduce stream flow and biodiversity (Bates et al. 2008). Water extraction is a high level threat to Atlantic salmon, as adequate water quantity and quality are critical for all life stages of Atlantic salmon (NMFS and USFWS 2005). Climate change will also affect precipitation, with northern areas predicted to become wetter and southern areas predicted to become drier in the future (Karl et al. 2009). Droughts may further exacerbate poor water quality and impede or prevent migration of Atlantic salmon (Riley et al. 2009).

It is anticipated that these climate change effects could significantly affect the functioning of the Atlantic salmon critical habitat. Increased temperatures will affect the timing of upstream and downstream migration and make some areas unsuitable as temporary holding and resting areas. Higher temperatures could also reduce the amount of time that conditions are appropriate for migration (less than 23 degrees Celsius), which could affect an individual's ability to access suitable spawning habitat. In addition, elevated temperatures will make some areas unsuitable for spawning and rearing due to effects to egg and embryo development. We are not able to predict with precision how climate change will impact Atlantic salmon and/or designated critical habitat in the action area or how the species will adapt to climate change-related environmental impacts; no additional effects related to climate change to Atlantic salmon and/or designated critical habitat the action area are anticipated over the term of this study.

8.1.3 Effects on Atlantic and Shortnose Sturgeon

Global climate change may affect all DPSs of Atlantic sturgeon and shortnose sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to affect the South Atlantic and Carolina DPSs versus the northern DPSs (GOM, NYB, and Chesapeake Bay). Because the unnaturally warm Caribbean and equatorial waters will continue to be entrained in and transported north by the prevailing ocean currents, the southern-most DPSs of Atlantic sturgeon will experience the biggest increases in water temperature, prior to the Gulf Stream cooling as it moves north. As noted above, global climate change will very likely affect the entire hydrologic cycle (*i.e.* be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency and duration of both very wet and very dry conditions).

Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic and shortnose sturgeon spawning occurs in freshwater reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile sturgeon have limited tolerance to salinity and remain in waters with little to no 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 salt wedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge in the action, for most spawning rivers there are no predictions on the timing or extent of any 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 salt wedge. As discussed previously, it is unlikely that shifts in the location of the salt wedge would eliminate freshwater spawning or rearing habitat for sturgeon. If habitat was severely restricted, productivity or survivability of either sturgeon species may decrease.

The increased rainfall predicted by some models in select areas may increase runoff and scour spawning areas, and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with dissolved oxygen and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Atlantic and shortnose sturgeon are tolerant to water temperatures up to approximately 28 degrees Celsius (82.4 degrees Fahrenheit); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28 degrees Celsius are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in select areas 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, all sturgeon life stages, including adults, may become susceptible to stranding. 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, causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species.

8.2 Directed Harvest

MEDMR closed all Atlantic salmon fishing throughout the state of Maine in 2009. There is no indication that the fishery will be reinstated in the foreseeable future. While unauthorized take of Atlantic salmon is prohibited by the ESA, it is possible that, if present, Atlantic salmon juveniles may be taken incidentally in fisheries by recreational anglers. Due to a lack of reporting, no information on the number of Atlantic salmon caught and released or killed in recreational fisheries in the Kennebec River is available.

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 of 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 19 to 75 percent in the next 100 years (Fay et al. 2006). Total returns of Atlantic salmon to U.S. rivers in 2019 were 1,535 salmon and are the sum of documented returns to traps and returns estimated by redd counts. Most returns (1,528, 99.5 percent) were attributed to the GOM DPS, which includes the Penobscot River, Kennebec River, and Eastern Maine coastal rivers with only seven returns documented outside of the GOM DPS (USASAC 2020). These returns (1,528) represent a 1.8 fold increase from 2018 (869).

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 1997). The sturgeon fishery during the early years (1870 through 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 1997). 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 2.1 meter (7 feet) 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 to 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 NYB 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 NYB DPS.

8.3 Bycatch

Bycatch and discard of Atlantic salmon is monitored annually by the NMFS Northeast Fisheries Science Center using the Standardized Bycatch Reporting Methodology. While bycatch is uncommon, the U.S. Atlantic Salmon Assessment Committee recently summarized observed events from 1989 through September 2019 using reports and data queries (USASAC 2020). Prior to 1993, observers recorded Atlantic salmon as an aggregate weight per haul. Therefore, no individual counts are available for these years, however eight observed interactions occurred. After 1993, observers recorded Atlantic salmon on an individual basis. Between 1993 and 2019, seven observed interactions occurred for a total of seven individuals. In total, Atlantic salmon bycatch has been observed across seven statistical areas in the GOM region, primarily in benthic fisheries. Four interactions were observed in bottom otter trawl gear and 11 interactions were observed in sink gillnet gear. Bycatch of Atlantic salmon is a rare event as interactions have been observed in only seven years of a 30-year time series and no Atlantic salmon have been observed since August 2013 (USASAC 2020).

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 2007; 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 (less than 300 spawning adults per year). Reported mortality rates of sturgeon (Atlantic and shortnose) captured in inshore and riverine fisheries range from eight 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 1995a). 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 opinion on the following fisheries: Northeast multispecies; monkfish (*Lophius* spp.); spiny dogfish (*Squalus acanthias*); Atlantic bluefish (*Pomatomus saltatrix*); Northeast skate complex (consisting of seven skate species); mackerel/squid/butterfish; and summer flounder (*Paralichthys dentatus*)/scup (*Stenotomus* *chrysops*)/black sea bass (*Centropristis striata*). The Northeast multispecies fishery includes American plaice (*Hippoglossoides platessoides*), Atlantic cod (*Gadus morhua*), Atlantic halibut (*Hippoglossus hipooglossus*), Atlantic wolfish (*Anarhichas lupus*), haddock (*Melanogrammus aeglefinus*), ocean pout (*Zoarces americanus*), offshore hake (*Merluccius albidus*), pollock (*Pollachius pollachius*), redfish (*Sciaenops ocellatus*), red hake (*Urophycis chuss*), silver hake (*Merluccius bilinearis*), white hake (*Urophycis tenuis*), windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), witch flounder (*Glyptocephalus cynoglossus*), and yellowtail flounder (*Pleuronectes ferruginea*). 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 percent) 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 through 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 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. 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 opinion on the Southeast shrimp trawl fishery concluded the fishery is unlikely to jeopardize Atlantic sturgeon. This 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 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.

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 through 2006, an estimated 649 Atlantic sturgeon were killed annually in offshore gill net and otter trawl fisheries. From 2006 through 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 1998a) 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 eight 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).

Atlantic and shortnose sturgeon are taken incidentally in anadromous fisheries along the east coast and may be targeted by poachers (NMFS 1998, ASSRT 2007). The Kennebec River is an important corridor for migratory movements of various species including alewife, American eel, blueback herring, American shad, rainbow smelt, striped bass (*Morone saxatilis*), and lobster (*Homarus americanus*). Historically, the river and its tributaries supported the largest commercial fishery for shad in the State of Maine. However, pollution and the construction of dams decimated the shad runs in the late 1920s and early 1930s. Shortnose sturgeon in the Kennebec River may have been taken as bycatch in the shad fishery or other fisheries active in the action area. The incidental take of shortnose sturgeon in the river has not been well documented due to confusion over distinguishing between Atlantic sturgeon and shortnose sturgeon. Due to a lack of reporting, no information on the number of Atlantic or shortnose sturgeon caught and released or killed in commercial or recreational fisheries on the Kennebec River is available.

8.4 Water Quality and Contaminants

The quality of water in river/estuary systems is affected by human activities conducted in the riparian zone and those conducted more remotely in the upland portion of the watershed. Industrial activities can result in discharge of pollutants, changes in water temperature and levels of dissolved oxygen, 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 impacted by real estate development and urbanization resulting in storm water discharges, non-point source pollution, and erosion. The Clean Water Act regulates water quality in the U.S. and, when enforcement of those regulations fails to adequately protect water quality, section 303(d) of the

Clean Water Act identifies polluted water bodies that require the establishment of a total maximum daily load (TMDL) for a pollutant in order to improve water quality.

The water quality over the range of Atlantic and shortnose sturgeon varies by watershed but is notably poorer in the north than in the south. The EPA published its fourth edition of the National Coastal Condition Report (NCCR IV) in 2012, a "report card" summarizing the status of coastal environments along the coast of the U.S. (EPA 2012) is summarized in Table 8 (Table ES-4 of their report). The report analyzes water quality, sediment, coastal habitat, benthos, and fish contaminant indices to determine status on a range from good to fair to poor. The northeast region of the U.S. (Virginia to Maine) was rated fair.

Table 8. Summary of the Environmental Protection Agency's National Coastal Condition Report (third edition) for the United States east coast published by (EPA 2012) grading coastal environments.

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

Chemicals such as chlordane, dichlorodiphenyl dichloroethylene (DDE), dichlorodiphenyltrichloroethane (commonly known as DDT), dieldrin, polychlorinated biphenyl (commonly known as 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 salmon and sturgeon). Some of these compounds may affect physiological processes and impede a fish's ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing dissolved oxygen, altering pH, and altering other physical properties of the water body.

Pollutants discharged to the Kennebec and Sebasticook Rivers from point sources and non-point sources affect water quality within the action area. Common point sources of contaminants include publicly operated waste treatment facilities and industrial discharges. Agriculture and animal husbandry are frequent non-point sources of contaminated effluents.

The State of Maine classifies the Kennebec River reach that encompasses the action area as Class C. Under Maine Revised Statutes, Title 38, §465, Class C water bodies are defined as those that must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Maine Revised Statutes Title 12, section 403; navigation; and as a habitat for fish and other aquatic life.

Over 321.9 kilometers (200 miles) of the Kennebec River and its tributaries, including all ten reaches where sampling is proposed, are listed as impaired (MEDEP 2013). In their 2012 Integrated Water Quality Monitoring and Assessment Report, the Maine Department of Environmental Protection (MEDEP) describes the Kennebec and Sebasticook River action areas as impaired due to elevated levels of two environmentally persistent carcinogenic compounds: dioxin and PCBs. Combined sewer overflows (CSOs) from Skowhegan to the Gardiner-Randolph region on the river produce elevated bacteria levels, inhibiting recreational uses of the river (primary contact). Further, the Kennebec River has fish consumption restrictions due to the presence of dioxin from industrial point sources. The Sebasticook River is also contaminated with PCBs and other persistent hazardous materials. Pollution has long been a major problem for this river system, including current discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons) as well as legacy pollutants such as PCBs.

MEDEP issues permits under the National Pollutant Discharge Elimination System (NPDES) for licensed point source discharges. Conditions and license limits are set to maintain the existing water quality classification. With a combined population of nearly 35,000 people, the Waterville- Augusta action area is one of the more densely populated reaches of the river. For reaches of rivers and streams within the Kennebec River watershed that do not meet designated uses, MEDEP calculates a TMDL for pollutants and allocates a waste load for each particular pollutant.

Water quality and quantity in the lower Kennebec River has drastically improved since log drives in the river were halted in the mid-1970s. The elimination of the log drives, along with the implementation of water quality regulations and the removal of Edwards Dam, have led to these improvements. However, as mentioned above, the water quality in the action area is still considered degraded and does not meet state standards for all designated uses (MEDEP 2013).

Contaminants including heavy metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and PCBs, can have serious, deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like sturgeon are particularly vulnerable.

Several characteristics of sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long-term, repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979a). Contaminant analysis of tissues from a shortnose sturgeon from the Kennebec River revealed the presence of 14 metals, one semivolatile compound, one PCB (Aroclor), Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (Environmental Research and Consulting 2002). Thomas and Khan (1997) demonstrated that exposure to cadmium at concentrations well below the concentration detected in the shortnose sturgeon significantly increased ovarian production of estradiol and testosterone which can adversely affect reproductive function. The concentration of zinc detected in the shortnose sturgeon liver tissue was slightly less than the effect concentration for reduced egg hatchability reported by (Holcombe et al. 1979) and exceeded the effect concentration for reduced survival cited in Flos et al. (1979).

Ruelle and Henry (1992) determined that heavy metals and organochlorine compounds (i.e., PCBs) accumulate in fat tissues. Although the long-term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. PCBs may also contribute to a decreased immunity to fin rot. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increase proportionally with fish size (NMFS and USFWS 1998).

Point source discharges (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon and salmon populations. The compounds associated with discharges can alter the pH or receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

As mentioned above, life histories of Atlantic and shortnose sturgeon predispose them to long-term, repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979b; NMFS 1998a; NMFS and USFWS 1998). 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 above adverse effect concentration levels reported in the literature (Environmental Research and Consulting 2002).

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

Sensitivity to environmental contaminants also varies by life stage. Early life stages of fish appear to be more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976). Dwyer et al. (2005) compared the relative sensitivities of common surrogate species used in contaminant studies to 17 ESA-listed species including Atlantic and shortnose 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 and shortnose sturgeon were ranked the two most sensitive species tested (Dwyer et al. 2005). Additionally, a study examining the effects of coal tar, a byproduct of the process of destructive distillation of bituminous coal, indicated that components of coal tar are toxic to shortnose sturgeon embryos and larvae in whole sediment flow-through and coal tar elutriate static renewal (Kocan et al. 1993).

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

8.5 Dams

The upstream extent of the survey area in both the Kennebec and Sebasticook Rivers are delineated by hydroelectric dams. While there are no dams in the actual action area, the controlled release or impoundment of water associated with hydroelectric dams can still negatively impact Atlantic salmon and sturgeon within the action area.

According to Fay et al. (2006), the greatest impediment to self-sustaining Atlantic salmon populations in Maine is obstructed fish passage and degraded habitat caused by dams. In addition to direct loss of production in habitat from impoundment and inundation, dams also alter natural river hydrology and geomorphology, interrupt natural sediment and debris transport processes, and alter natural temperature regimes (Wheaton et al. 2004). These impacts can have profound effects on aquatic community composition and adversely affect aquatic ecosystem structure and function. Furthermore, impoundments can significantly change the prey resources available to salmon due to the existing riverine aquatic communities upstream of a dam site being replaced by lacustrine communities following construction of the dam. Anadromous Atlantic salmon inhabiting the GOM DPS are not well adapted to these artificially created and maintained impoundments (NRC 2004). Conversely, other aquatic species that can thrive in impounded riverine habitat will proliferate and can significantly change the abundance and species composition of competitors and predators.

Operation of hydroelectric storage dams on these rivers results in lesser spring runoff flows, lesser severity of flood events, and augmented summer flows (FERC 1997). Although few Atlantic salmon naturally occur in the lower Kennebec River due to the lack of upstream fish passage at the main stem dams, available rearing habitat for Atlantic salmon is impacted by alteration of the natural hydrograph (Fay et al. 2006). Additionally, the lower Kennebec River serves as *the* migratory pathway for all Atlantic salmon stocked in the upper watershed and changes in the hydrology brought about by dams likely affects the species' migration. In addition to direct mortality while passing through a dam's turbines during seaward migrations, kelts and smolts are exposed to indirect mortality caused by sub-lethal injuries, increased stress, and/or disorientation. A large proportion of indirect mortality is a result of disorientation caused by downstream passage, which can then lead to elevated levels of predation immediately downstream of the dam (Ferguson et al. 2006; Mesa 1994; Ward et al. 1995).

Hydroelectric dams may affect Atlantic and shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration, and causing mortalities to fish that become entrained in turbines.

Connectivity is disrupted by the presence of dams on several rivers in the GOM region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin, and Saco Rivers, these dams are near the sites of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present.

Because no sturgeon are known to occur upstream of any hydroelectric projects in the GOM region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. While not expected to be killed or injured during passage at a dam, the extent that Atlantic sturgeon are affected by the existence of dams and their operations in the GOM region is currently unknown.

The documentation of Atlantic sturgeon larvae downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least that dam site and, therefore, may be affected by dam operations. Historically, the first natural obstacle to Atlantic sturgeon migration on the Penobscot River may have been the impassable ledge falls at Milford, river kilometer 71. The current range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Milford Dam, which is built on the site of the ledge falls. If sturgeon were able to ascend the falls or bypass the dam at Milford, they could have migrated without obstruction to Mattaseunk (river kilometer 171). While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Milford Dam affects the likelihood of spawning in this river. The Essex Dam on the Merrimack River blocks access to approximately 58 percent of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Milford Dam on the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning in the Merrimack River.

On July 19, 2013, NMFS Greater Atlantic Regional Fisheries Office (GARFO) issued an opinion to the Federal Energy Regualtory Commision (FERC) on the impacts to ESA-listed species from operations of the Lockwood, Shawmut, and Weston Projects on the Kennebec River; as well as the Brunswick, and Lewiston Falls Projects on the Androscoggin River. The GARFO opinion served as the basis of an interim Species Protection Plan (ISPP). GARFO's conclusion was that the proposed action was likely to adversely affect, but not likely to jeopardize the continued existence of the GOM DPS of Atlantic salmon, shortnose sturgeon, or any of the five DPSs of Atlantic sturgeon. They also concluded that the action was not likely to destroy or adversely modify critical habitat designated for Atlantic salmon. The purpose of the ISPP is to collect information on passage efficiency and survival of Atlantic salmon adults and smolts attempting to migrate past the Projects. Lewiston Falls does not have fishways, so passage efficiency studies were not proposed at that project. The ITS of the opinion authorized take for the proposed studies, as well as for the effects of ongoing operations at the Projects. The ISPPhad a seven-year term (2013 through 2019), after which reinitiation of consultation may be needed.

The ITS accompanying GARFO's opinion exempted incidental take for upstream and downstream fish passage studies, as well as for the operation of the Projects over the term of the ISPP. The ITS also exempted incidental take of Atlantic sturgeon (four in the fishway and four stranded) and four trapped shortnose sturgeon at the Lockwood Project (license expires in 2036), and another four trapped fish of each species (four in the fishway and four stranded) at the Brunswick Project (license expires in 2029). Neither mortality nor major injuries of any sturgeon is anticipated or exempted.

8.6 Dredging

The dissolved oxygen concentrations in the water column can also be affected by maintenance dredging of federal navigation channels and other waters. Some of the consequences of dredging include entrainment of fish and changing dissolved oxygen and salinity gradients in, and around, the channels (Campbell and Goodman 2004; Jenkins et al. 1993; Secor and Niklitschek 2001). Hydraulic dredges can kill sturgeon by entraining sturgeon in dredge drag arms and impeller pumps. Mechanical dredges have also been documented to kill shortnose sturgeon. Dredging operations may pose risks to shortnose sturgeon by destroying or adversely modifying, their benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments (Jones 1986; Van Dolah et al. 1984). Because shortnose sturgeon are benthic omnivores, the modification of the benthos could affect the quality, quantity and availability of sturgeon prey species (Haley 1998).

Currently, there are two dredging projects ongoing in the Kennebec River – both south of the action area. These projects are the U.S. Navy Federal Navigation Project (2019 through 2029) and Bath Iron Works Dredging Project (2020 through 2029). Both actions have been recently evaluated in opinions written by GARFO and both opinions allow for the lethal take of ESA-listed species considered in this opinion.

For the U.S. Navy action, GARFO estimated that, from 2019 through 2029, dredging has the potential to result in the mortality of shortnose sturgeon and individuals from the GOM DPS of Atlantic sturgeon due to entrainment in hopper dredges or capture in a mechanical dredge. Specifically, through 2029, the ITS exempts the lethal take of 29 shortnose sturgeon (juveniles or adults) and five GOM DPS of Atlantic sturgeon (juveniles, subadults, or adults) (GARFO 2019).

For the Bath Iron Works opinion, GARFO concluded that the proposed action has the potential to result in the mortality of shortnose sturgeon and individuals from the GOM DPS of Atlantic sturgeon due to capture in a mechanical dredge. Specifically, through 2029, the ITS exempts the lethal take of three shortnose sturgeon (juveniles or adults) and three GOM DPS Atlantic sturgeon (juveniles, subadults, or adults) (GARFO 2020).

There are no known incidences of Atlantic salmon being captured in a mechanical dredge. Atlantic salmon are highly mobile and not likely to be concentrated in areas of dredging activity. Therefore, there is little risk of individuals being captured. The risk of capture is further reduced by the distribution of Atlantic salmon in the upper water column, not near the bottom where mechanical buckets are active. Though a dredge bucket may be open (depending on the type of bucket used) as it travels through the water column, the low number and sparse spatial concentration of Atlantic salmon make effects of dredging capture extremely unlikely.

8.7 Vessel 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 deeper 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 vessel strikes, and sturgeon in the James River are at a moderate risk from vessel strikes (ASSRT 2007).

Brown and Murphy (2010) examined 28 dead Atlantic sturgeon from the Delaware River from 2005 through 2008 and found that 50 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 14 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. Vessel 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 1.8 meters (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.

Balazik et al. (2012) estimated up to 80 sturgeon were killed between 2007 and 2010 in these two river systems (James and Delaware Rivers). Their study showed that adult male Atlantic sturgeon spent most (62 percent) of the time within one meter of the river bottom. Their conclusions suggest that if sturgeon behavior is not modified by vessel noise, adult male Atlantic sturgeon in the James River would rarely encounter small recreational boats or tugboats with shallow drafts; instead, mortalities are likely caused by deep-draft ocean cargo ships (Balazik et al. (2012).

Large sturgeon are most often killed by vessel 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 vessel strikes have been documented more frequently. There has only been one confirmed incidence of a vessel strike on a shortnose sturgeon in the Kennebec River, and two suspected vessel strike mortalities in the Delaware River (SSSRT 2010).

8.8 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.

MEDMR is authorized under the U.S. Fish and Wildlife Services' endangered species blanket permit (No. 697823) to conduct monitoring, assessment, and habitat restoration activities for ESA-listed Atlantic salmon populations in Maine. The extent of take from MEDMR activities during any given year is not expected to exceed two percent of any life stage being impacted; for adults, it would be less than one percent. MEDMR will continue to conduct Atlantic salmon research and management activities in the GOM DPS while the proposed action is carried out. The information gained from these activities will be used to further salmon conservation actions.

U.S. Fish and Wildlife Service is also authorized under an ESA section 10 endangered species blanket permit to conduct the conservation hatchery program at the Craig Brook and Green Lake National Fish Hatcheries. The mission of the hatcheries is to raise Atlantic salmon parr and smolts for stocking into selected Atlantic salmon rivers in Maine. Over 90 percent of adult returns to the GOM DPS are currently provided through production at the hatcheries. The hatcheries provide a significant buffer from extinction for the species.

The University of Maine holds a scientific research permit (No. 20347) to capture, tag, and sample genetic material from shortnose sturgeon and Atlantic sturgeon from 2017 through 2027. The University of Maine proposes to:

1. Combine acoustic telemetry, blood analysis, genetics and scute spine analysis to determine spawning periodicity for each sex and species and river of origin;
2. Compare aging of fin spines/rays and scute spines to determine if scute spines are an alternate means of ageing fish; and
3. Use mark-recapture and acoustic telemetry to identify critical habitat for juveniles, estimate annual juvenile recruitment, and movement within and between river systems.

Across Gulf of Maine rivers and coastal marine habitat, their objectives for Atlantic sturgeon include capturing a maximum of 845 adults/subadults, 138 juveniles, and 200 early life stages (early life stages; eggs and larvae). All adults, subadults, and juveniles will be weighed, measured, examined for tags, examined with a borescope when appropriate, marked with PIT tags and T-bar or Floy tags, photographed, and sampled for genetic material (i.e. a fin clip) and blood prior to being released. Their objectives for shortnose sturgeon include capturing a maximum of 1,535 adults, 189 juveniles, and 210 ELS. All adults, sub-adults, and juveniles will be weighed, measured, examined for tags, examined with a borescope when appropriate, marked with PIT tags and T-bar or Floy tags, photographed, and sampled for genetic material (i.e. a fin clip) and blood prior to being released.

Specific to the Kennebec River System (including the Androscoggin River), they propose to capture and handle as many as 200 Atlantic sturgeon (all DPSs) and 400 shortnose sturgeon.

They also propose to capture 100 Atlantic sturgeon eggs/larvae from the GOM DPS and 50 shortnose sturgeon eggs/larvae, resulting in mortality. Over the lifetime of the permit, they also expect the unintentional mortality of one Atlantic sturgeon adult/subadult (all DPSs), one Atlantic sturgeon juvenile (all DPSs), two shortnose sturgeon adults, and two shortnose sturgeon juveniles.

9 EFFECTS OF THE ACTION

Section 7 regulations define "effects of the action" as "all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action" (50 C.F.R. §402.02).

9.1 Exposure Analysis

The Exposure Analysis identifies, as possible, the number, age (or life stage), and gender of the individual ESA-listed GOM DPS of Atlantic salmon, NYB and GOM DPS Atlantic sturgeon, and shortnose sturgeon that are likely to be exposed to electrofishing. Stressors of the proposed action that may affect, but are not likely to adversely affect ESA-listed fish were discussed in Section 6.3.3.

9.1.1 Electrofishing

Electrofishing can cause mortality or injury to ESA-listed fish. Fish encountering the electric current typically undertake an involuntary movement toward the positive electrode. Harmful effects to fish during electrofishing can include spinal injuries, bleeding at gills or vent, hemorrhaging, and excessive physiological stress (Snyder 2004). Snyder (2004), however, states that injuries heal and seldom result in delayed mortality if electrofishing is conducted carefully. Handling and anesthesia associated with electrofishing surveys can also cause harm to fish. Snyder (2004), in a review of the effects of electrofishing on fish, notes that electrofishing mortalities related to asphyxiation are often the result of poor handling. However, as stated earlier, listed fish stunned by the electric current will not be removed from the water.

Despite occasional reports of substantial harm to fish, the relatively benign nature of electrofishing had been assumed because generally fish recovered quickly and few mortalities or external injuries were observed or reported. Also, the most frequently noted external effects, brands (bruises), were often dismissed by experienced electrofishers as harmless, temporary effects, rather than as indicators of potentially serious spinal injuries or hemorrhages. However, since the late 1980s, many investigators have shown that assessment of electrofishing injuries based only on externally obvious criteria can be highly inadequate (Snyder 2004).

Evidence to date indicates that trout, char, and salmon (subfamily Salmoninae) are more susceptible to spinal injuries, associated hemorrhages, and probable mortality during electrofishing than most other fishes (McMichael et al. 1998). Because the voltage differential across fish or specific tissues increases with size, larger fish have been expected to be more susceptible to electrofishing mortality and injury than smaller fish. Some data support an increased frequency of spinal injuries as fish size increases, but other data do not, and so the importance of size remains questionable (Snyder 2004).

Based upon the best available data, Atlantic salmon, shortnose sturgeon, and/or Atlantic sturgeon could be present in any of the proposed sample sites in the Kennebec or Sebasticook Rivers. Due to the time of year when sampling will occur and the types of habitats that will be sampled, no spawning or overwintering fish will be affected; similarly, no salmon eggs or sturgeon eggs or other early life stages would be present in the action area. Furthermore, as all sampling will take place in deeper, non-wadeable habitats, no salmon smolts or parr would occur in the areas to be sampled. Finaly, no early juvenile stage sturgeon will be present in the action area at the time of sampling. Therefore, the only Atlantic salmon likely to be exposed to effects of the action are adults, and the only shortnose sturgeon or Atlantic sturgeon likely to be exposed to effects of the action are adults or older subadults.

9.1.1.1 Atlantic Salmon Encounters in the Lower Kennebec River 2002-2019

Atlantic Salmon have been encountered once (two fish; RM 5.3) in the Sebasticook River and 14 times (20 fish) in the Lower Kennebec River during MBI assessment surveys from 2002 through 2019 (Table 9). The first encounters occurred prior to Atlantic salmon being ESA-listed as endangered with four fish being collected in 2002 (RM15.1 and RM15.3). Encounters from 2003 to 2019 have consisted of one to two fish every year with several years where no Atlantic salmon were encountered during some years (Table 9). No Atlantic salmon were encountered from 2015 through 2019 when a single (1) adult was encountered at Waterville (RM 17.4). The trend since 2010 has been for a decreasing number of encounters and then only at the furthest upstream sites in the Lower Kennebec River. This annual pattern of occurrence in the Lower Kennebec River fish sampling is generally consistent with the number of fish appearing in the fish lift at the Lockwood Dam and Hydropower Project, which has generally been less than ten fish annually (Table 10; https://www.maine.gov/dmr/science-research/searun/programs/trapcounts.html). The number of returning adults in the Kennebec River is highly variable, ranging from 64 fish in 2011 to five in both 2010 and 2012 with an average of approximately 28 salmon per year. Atlantic salmon adults have been documented in the action area in September and October (MBI 2020) and it is reasonable to expect that Atlantic salmon will be encountered during electrofishing surveys. All of the Lower Kennebec locations were sampled twice each year during the late summer and early fall of 2002 through 2019.

Table 9. Endangered Species Act-listed species collected by electrofishing in the Lower Kennebec and Lower Sebasticook Rivers 2002 through 2019.

Year	River	River Mile	Common Name	Number
2002	Kennebec River	15.1	Atlantic Salmon	2
2002	Kennebec River	15.3	Atlantic Salmon	2
2003	Kennebec River	16.5	Atlantic Salmon	1
2004	Kennebec River	17.4	Atlantic Salmon	1
2004	Kennebec River	17.6	Atlantic Salmon	1
2009	Kennebec River	15.1	Atlantic Salmon	2
2010	Kennebec River	15.1	Atlantic Salmon	1
2011	Kennebec River	16.5	Atlantic Salmon	1
2011	Kennebec River	9	Atlantic Salmon	1
2011	Sebasticook River	5.3	Atlantic Salmon	2
2012	Kennebec River	17.4	Atlantic Salmon	1
2012	Kennebec River	15.1	Atlantic Salmon	1
2013	Kennebec River	15.1	Atlantic Salmon	1
2015	Kennebec River	17.1	Atlantic Salmon	1
2019	Kennebec River	17.4	Atlantic Salmon	1
2005	Kennebec River	4.2	Atlantic Sturgeon	1
2012	Kennebec River	9	Atlantic Sturgeon	1
2014	Kennebec River	17.4	Atlantic Sturgeon	1
2014	Kennebec River	0.1	Atlantic Sturgeon	1
2018	Kennebec River	4.2	Atlantic Sturgeon	1
2019	Kennebec River	9	Atlantic Sturgeon	1
2012	Kennebec River	9	Shortnose Sturgeon	3
2014	Kennebec River	0.1	Shortnose Sturgeon	1
2016	Kennebec River	9	Shortnose Sturgeon	1
2016	Kennebec River	0.1	Shortnose Sturgeon	1
2017	Kennebec River	0.1	Shortnose Sturgeon	1
2017	Kennebec River	0.1	Shortnose Sturgeon	1
2018	Kennebec River	15.1	Shortnose Sturgeon	1
2019	Kennebec River	15.1	Shortnose Sturgeon	1

2019	Kennebec River	9	Shortnose Sturgeon	3
2019	Kennebec River	4.2	Shortnose Sturgeon	1

Some early collections were made prior to a species being listed under the Endangered Species Act and/or the Lower Kennebec River being designated as a critical habitat.

Table 10. Number of Gulf of Maine distinct population segment of Atlantic salmon counts at the Lockwood Dam on the Kennebec River from 2009 through 2019.

Year	Number of Atlantic Salmon
2009	33
2010	5
2011	64
2012	5
2013	8
2014	18
2015	31
2016	39
2017	40
2018	11
2019	56

Source: https://www.maine.gov/dmr/science-research/searun/programs/documents/trapcounts.pdf

Based on previous electrofishing work, we anticipate no more than five GOM Atlantic salmon adults may experience effects from electrofishing annually due to the proposed action. This represents about 0.3 percent of the estimated adult returns in 2019, and about 1.2 percent of the lowest value of estimated adult returns (i.e., 405 fish in 2014) over the past several decades (USASAC 2016).

9.1.1.2 Atlantic Sturgeon Encounters in the Lower Kennebec River 2002 through 2019

Atlantic Sturgeon have been encountered six times during fish sampling conducted by MBI in the Lower Kennebec River during 2002 through 2019 and are listed in Table 9. The first encounter occurred in 2005 with a single adult that was "rolled" at Sevenmile Island (RM 4.0) in the Kennebec River. This individual vigorously escaped the immediate vicinity when the electric current was interrupted. No other Atlantic sturgeon were encountered in the Kennebec River until 2012 when there was a single animal seen (RM 9.0). In 2014 there were individuals seen, one below the Lockwood Dam (RM 17.4) in Waterville and the other at Augusta (RM 0.1), each under the Terms and Conditions of the first section 7 ITS (NMFS 2011). The second encounter in 2014 triggered a reinitiation of consultation as the take limit of one fish was reached at the final site of the 2014 survey. The next encounters happened under the most recent section 7 ITS

(NMFS 2015) as single adults at Sevenmile Island (RM 4.0) in 2018 and at Sidney, Maine (RM 9.0) in 2019. As with the first encounter in 2005, fish were observed to swim away vigorously when the electric current was interrupted. All reasonable and prudent measures specified by the ITS were observed by interrupting the electric current immediately, not netting any fish, ensuring that the fish were able to swim away under their own power, and not resuming sampling for a period of five minutes. All of the Lower Kennebec River locations were sampled twice each year during the late summer and early fall months.

Population estimates for the GOM and NYB DPSs of Atlantic sturgeon were reported by Kocik et al. (2013) to be 15,393 and 68,568 individuals, respectively. Based on the population estimates it is possible to proportion the previous encounters based on proportions provided by Kocik et al. (2013). This results in one animal belonging to the GOM DPS (18 percent) and five from the NYB DPS (82 percent). These assume a pooled number of sightings over the entire 18 years of surveys. Alternatively, the annual number of sightings could be attributed to either DPS.

Therefore, given the previous number of encounters and the estimated proportions of sturgeon attributed to each DPS, we can estimate that 0.001 percent of exposed Atlantic sturgeon would be from the GOM DPS (1) and 0.006 percent would be attributed to the NYB DPS (5) for 1998 through 2000 and over the entirety of the Lower Kennebec River including the tidal reach downstream from the action area. No Atlantic sturgeon were encountered in the Lower Sebasticook River during 2008 through 2019.

9.1.1.3 Shortnose Sturgeon Encounters in the Lower Kennebec River 2002 through 2019

Shortnose sturgeon have been encountered 14 times at multiple sites in the lower Kennebec River study area during 2012 to 2019 (Table 9). The first shortnose sturgeon encountered consisted of three adults at Sidney, Maine (RM 9.0) in 2012 under the first section 7 ITP (NMFS 2011). The next encounters consisted of a single adult at Augusta (RM 0.1) in 2014, single adults at Sidney (RM 9.0) and Augusta (RM 0.1) in 2016, two single adults in 2017 during each of two sampling passes at Augusta (RM 0.1), a single adult at Petty's Rips (RM 15.1) near Waterville in 2018, and five adults at three sites in 2019 – a single adult at Petty's Rips (RM 15.1) near Waterville, three adults at Sidney (RM 9.0), and a single adult at Sevenmile Island (RM 4.0) all under the second ITP (NMFS 2015). There were 14 individuals collected over 18 years. These individuals account for 0.15 percent of the 9,436 individuals population estimate by Wippelhauser and Squiers (2015) for 1998 through 2000 and over the entirety of the Lower Kennebec River including the tidal reach downstream from our study area. The recent trend has been for encounters at sites further upstream in the Lower Kennebec River study area which may well be the result of the almost two-fold increase in the population since 1977 through 1981 (Wippelhauser and Squiers 2015). As with the first encounter in 2012, all affected fish were observed to swim away under their own power. The reasonable and prudent measures specified by the section 7 ITSs were observed by interrupting the electric current immediately, not netting any fish, ensuring that the fish were able to swim away under their own power, and not resuming sampling for a period of five minutes. All of the Lower Kennebec River locations were sampled twice each year during the late summer and early fall months.

Therefore, based on previous survey data which show a sighing rate of less than one shortnose sturgeon per year, we estimate that a small fraction of the population of shortnose sturgeon in the Kennebec and Sebasticook Rivers would be exposed to the effects of the electrofishing surveys. No shortnose sturgeon were encountered in the Lower Sebasticook River during 2008 through 2019.

9.1.1.4 Summary of Endangered Species Act-Listed Species Exposure Analysis

There were 17 Atlantic salmon, 14 shortnose sturgeon, and six Atlantic sturgeon seen during electrofishing surveys conducted between 2002 and 2019 in the Kennebec River. No sturgeon and only two salmon have been seen during electrofishing surveys in the Sebasticook River between 2008 and 2019 when surveys began in this river (Table 9).

Based upon the above information, we conclude that five adult Atlantic salmon, four shortnose sturgeon, and four Atlantic sturgeon may be exposed to the electrical current used during electrofishing activities annually during the survey.

9.2 Response Analysis

The *Response Analysis* evaluates the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. Given the exposure information detailed above, here we describe the range of responses among ESA-listed species that may result from the stressors associated with the proposed action. This analysis is focused on the stressors associated with the electrofishing survey methodology. Based on a review of available information, this consultation determined which of the possible stressors will be extremely unlikely to occur or insignificant (Section 6.3.3) and which may lead to lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. Our response analysis considers and weighs evidence of adverse consequences, as well as evidence suggesting the absence of such consequences.

9.2.1.1 Electrofishing

While individuals may be displaced from, or avoid, the electrified field: (1) there will always be a zone of passage (greater than 50 meters [164 feet]); (2) any changes in movements would be limited to a few minutes to an hour, when sampling would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health; and, (5) any temporary minor changes in behavior resulting from exposure to electrical current associated with electrofishing will not preclude any ESA-listed fish species considered in this opinion from completing essential behaviors such as resting, foraging, or migrating. Conducting in-stream activities associated with electrofishing could cause localized electrotaxis (*i.e*., stun, twitch, or roll). These potential behavioral responses are expected to be spatially and temporally limited to the immediate area and exact time when electrofishing is conducted and, as such, will be limited to only a few hours per day, divided among the ten discrete sampling locations. Previous MBI encounters with ESA-listed fish demonstrated the fishes ability to swim away and frequently doing so by vigorous leaping out of the water. All reasonable and prudent measures specified by the previous ITSs were observed by interrupting the electric current immediately, not netting any fish, ensuring that the fish were able to swim away under their own power, and not resuming sampling for a period of five minutes.

We expect all ESA-listed fish species that encounter the electrical current will fully recover within seconds to minutes. The proposed action is expected to have a very minor, short-term, adverse effect on Atlantic salmon (GOM DPS), Atlantic sturgeon (GOM and NYB DPSs), and shortnose sturgeon. No mortalities of any ESA-listed fish species are expected from the proposed action.

9.3 Risk Analysis

In this section, we assess the consequences of the responses of the individuals that have been exposed to the stressors we have identified as adversely impacting ESA-listed Atlantic salmon (GOM DPS), Atlantic sturgeon (GOM and NYB and GOM DPSs), and shortnose sturgeon, the populations those individuals represent, and the species those populations comprise. This section summarizes our analysis of the expected risk to individuals, populations, and species given the expected exposure of ESA-listed species to the proposed action, (as described in the *Exposure Analysis* (Section 9.1) and the response of those species to stressors discussed in the *Response Analysis* (Section 9.2).

We measure risk to individuals of threatened and endangered species based upon effects on the individual's "fitness," which may be indicated by changes to the individual's growth, survival, annual reproductive fitness, and lifetime reproductive success.

For the Gulf of Maine DPS of Atlantic salmon, the estimated annual incidental take due to electrofishing commensurate with the proposed take limit in the ITP is five Atlantic salmon per year. We therefore estimate an incidental take of 50 adult Atlantic salmon over the ten-year duration of the ITP. Based on 18 years of survey data from this action and an average "capture" rate of less than one fish per year, we expect only a very small percentage of the population of Gulf of Maine DPS of Atlantic salmon in the Kennebec or Sebasticook rivers to be affected by the electrofishing surveys.

For the GOM and NYB DPSs of Atlantic sturgeon, the proposed take limit under the IDP is four sturgeon per year due to electrofishing with no delineation of DPS. We therefore estimate an incidental take of 40 adult Atlantic sturgeon over the ten-year duration of the ITP. Based on previous data, (only six Atlantic sturgeon have been seen during the last 18 years of surveys) we expect potential sightings, and therefore, exposure of the population of GOM and/or NYB DPS

Atlantic sturgeon in the Kennebec and Sebasticook rivers to be low. These takes therefore represent a very small portion of either population as a result of the electrofishing surveys.

10 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 C.F.R. §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 future environmental changes 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 in 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.

We expect that those aspects described in the *Environmental Baseline* (Section 8) will continue to impact ESA-listed resources into the foreseeable future. We expect anthropogenic effects that include climate change, directed harvest, bycatch, water quality and contaminants, dams, dredging, vessel strikes, and scientific research and enhancement activities, to continue into the future for Atlantic salmon, and Atlantic and shortnose sturgeon. Many of these activities would involve a federal nexus and thus be subject to future ESA section 7 consultation. An increase in these activities could result in an increased effect on ESA-listed species; however, the magnitude and significance of any anticipated effects remain unknown at this time. The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on ESA-listed Atlantic salmon and Atlantic and shortnose sturgeon populations. Therefore, NMFS expects that the levels of interactions between human activities and sturgeon described in the *Environmental Baseline* will continue at similar levels into the foreseeable future. Movements towards the reduction of vessel strikes and fisheries interactions or greater protections of ESA-listed Atlantic salmon and Atlantic and shortnose sturgeon from these anthropogenic effects may aid in abating the downward trajectory of some populations and lead to recovery of other populations.

During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We conducted electronic searches of *Google* and other electronic search engines for other potential future state or private activities that are likely to occur in the action area. We are not aware of any non-Federal actions that are likely to occur in the action area during the foreseeable future that were not considered in the *Environmental Baseline* (Section 8).

11 INTEGRATION AND SYNTHESIS

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 9) to the *Environmental Baseline* (Section 8) and the *Cumulative Effects* (Section 10) 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. This assessment is made in full consideration of the *Status of the Species Likely to be Adversely Affected by the Proposed Action* (Section 7). For this consultation, we determined that the effects of the proposed action on designated critical habitat in the action area will be insignificant or extremely unlikely to occur (Section 6); therefore, only the risk to ESA-listed Atlantic salmon (GOM DPS) and sturgeon (i.e., GOM an NYB DPSs of Atlantic sturgeon and shortnose sturgeon) are analyzed in this section.

The following discussions separately summarize the probable risks to survival and recovery the proposed action poses to Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon that are likely to be exposed to electrofishing resulting from the issuance of ITP No. 23861. These summaries integrate the exposure profiles presented previously with the results of our response analysis for the stressor considered further in this opinion; specifically electrofishing.

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a 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 a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

11.1 Atlantic Salmon – Gulf of Maine Distinct Population Segment

The proposed action has the potential to directly affect Atlantic salmon of the GOM DPS by causing them to be stunned by the electric current associated with the proposed action. As explained in the *Effects of the Action* section (Section 9) of this consultation, no mortalities are likely, and all Atlantic salmon exposed to the current are expected to recover quickly. While Atlantic salmon may exhibit behaviors such as rolling or twitching after exposure to the electric field, no injuries or mortalities are likely to be sustained, and fish will recover.

The removal of the Edwards Dam has allowed GOM DPS Atlantic salmon to migrate further upstream and re-utilize habitat that has been inaccessible for over 150 years. The collection of ESA-listed fish by EPA during prior years' surveys has reflected the increasing number of Atlantic salmon in the action area. Due to the timing of the proposed study in relation to the timing of the adult run, it is anticipated that an extremely small proportion of the total annual run could still be migrating upstream in the Kennebec and Sebasticook rivers at the time that electrofishing activities are underway.

Considering that the upstream extent of two of the ten proposed sampling locations within action areas are delineated by the Lockwood and Benton Falls Dams, the probability of Atlantic salmon encounters increases because of the increase in population density of salmon that is likely to occur at the base of the dams due to the delay in migration. Recent data from the Lockwood Dam fish count location demonstrates that salmon returns from 2015 through 2018 average approximately 28 fish per season (see Table 10). While these numbers of returns have been increasing in the Kennebec and Sebasticook rivers), the likelihood of an adult being present at any given site is still relatively small.

Based on available population estimates, the known distribution of the species within the action area, the location of the sampling sites, and the effective range of the electrofishing unit, we have determined that no more than five adult Atlantic salmon from the GOM DPS are likely to be affected annually by the ten-year electrofishing survey. With this information, the fact that MBI has been conducting these surveys for 18 years, and with the multiple mitigation measures in place (see Section **Error! Reference source not found.**), we conclude that the continued surveys proposed by MBI are not anticipated to result in appreciable reductions in the overall reproduction, numbers, or distribution of the Gulf of Maine DPS Atlantic salmon, and will not significantly affect the continued recovery of this species in the Kennebec and/or Sebasticook rivers.

11.2 Atlantic Sturgeon – New York Bight and Gulf of Maine Distinct Population Segments

The proposed action has the potential to directly affect Atlantic sturgeon of the GOM and NYB DPSs by causing them to be stunned by the electric current. As explained in the *Effects of the Action* section (Section 9) of this consultation, no mortalities are anticipated, and all sturgeon exposed to the current are expected to recover quickly. While Atlantic sturgeon may exhibit behaviors such as rolling or twitching, no injuries or mortalities are likely to be sustained, and fish will recover.

Based on DPS composition in the action area, available population estimates, the known distribution of the species within the action area, the location of the sampling sites, and the effective range of the electrofishing unit, we have determined that no more than four Atlantic sturgeon from either the GOM or NYB DPS are likely to be effected annually by the ten-year electrofishing survey. With this information, the fact that MBI has been conducting these surveys for 18 years, and with the multiple mitigation measures in place (see Section **Error! Reference source not found.**), we conclude that the continued surveys proposed by MBI are not anticipated to result in appreciable reductions in the overall reproduction, numbers, or distribution of the New York Bight or Gulf of Maine DPS's of Atlantic sturgeon, and will not significantly affect the continued recovery of the either DPS of this species in the Kennebec and/or Sebasticook rivers.

11.3 Shortnose Sturgeon

The proposed action has the potential to directly affect shortnose sturgeon by causing them to be stunned by the electric current. As explained in the *Effects of the Action* section (Section 9) of this consultation, no mortalities are likely, and all shortnose sturgeon exposed to the current are expected to recover quickly. While shortnose sturgeon may exhibit behaviors such as rolling or twitching, no injuries or mortalities are likely to be sustained, and fish will recover.

In the past, shortnose sturgeon have generally spent summer months foraging lower in the watershed and moved upstream towards overwintering areas in the fall. The removal of the Edwards Dam has allowed shortnose sturgeon to occupy habitat that has been inaccessible for over 150 years. During prior years' surveys by EPA, capture of this species has reflected the increasing number of shortnose sturgeon in the action area.

Based on available population estimates, the known distribution of the species within the action area, the location of the sampling sites, and the effective range of the electrofishing unit, we have determined that no more than four individual shortnose sturgeon are likely to be effected annually by the ten-year electrofishing survey. With this information, the fact that MBI has been conducting these surveys for 18 years, and with the multiple mitigation measures in place (see Section **Error! Reference source not found.**), we conclude that the continued surveys proposed by MBI are not anticipated to result in appreciable reductions in the overall reproduction, numbers, or distribution of the shortnose sturgeon, and will not significantly affect the continued recovery of this species in the Kennebec and/or Sebasticook rivers.

12 Conclusion

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS biological opinion that the proposed action is not likely to jeopardize the continued existence of GOM DPS of Atlantic salmon, GOM DPS of Atlantic sturgeon, NYB DPS of Atlantic sturgeon, or shortnose sturgeon.

Furthermore, it is NMFS biological opinion that the proposed action may affect, but is not likely to adversely affect designated critical habitat of GOM DPS Atlantic salmon, GOM DPS Atlantic Sturgeon, or NYB DPS Atlantic sturgeon.

13 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 that "creates 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" (NMFSPD 02-110-19). 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(o)(2) provides 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 incidental take statement.

13.1 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 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take specifies the impact, i.e., the amount or extent of such incidental taking on the species, which may be used if we cannot associate numerical limits for animals that could be incidentally taken during the course of an action (see 80 FR 26832).

For the proposed action of the issuance of ITP No. 23861, incidental take is authorized under the permit for the GOM DPS of Atlantic Salmon, GOM and/or NYB DPSs of Atlantic sturgeon, and shortnose sturgeon.

Gulf of Maine DPS Atlantic Salmon
Electrofishing: five per year for ten years (adults)
Total: 50 adults over ten years

New York Bight and/or Gulf of Maine DPSs Atlantic Sturgeon
Electrofishing: four per year for ten years (subadults/adults) from either DPS
Total: 40 adults over ten years from either DPS

Shortnose Sturgeon
Electrofishing: four per year for ten years (subadults/adults)
Total: 40 adults over ten years

No lethal take is authorized.

13.2 Reasonable and Prudent Measures

Reasonable and prudent measures are non-discretionary actions (50 C.F.R. §402.02) that must be undertaken for the exemption in Section 7(o)(2) to apply. 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 threatened or endangered species. To minimize such impacts, RPMs, and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified RPMs and terms and conditions identified in the Incidental Take Statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA. Section 10 actions are unique in that they have the requirement under Section 10(a)(2)(B)(ii) to minimize and mitigate the impacts of taking to the maximum extent practicable. The mitigation, monitoring, and reporting are described in Section **Error! Reference source not found.** of this opinion.

In addition to the mitigation proposed by the applicant, NMFS Office of Protected Resources, Endangered Species Act Interagency Cooperation Division believes it is necessary and appropriate to minimize take of listed species and their critical habitat for NMFS Office of Protected Resources, Permits and Conservation Division to monitor and report the effects of the actions considered in this opinion to the Endangered Species Act Interagency Cooperation Division by March 1, each year.

13.3 Terms and Conditions

There are no terms and conditions associated with the reasonable and prudent alternative above.

14 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 C.F.R. §402.02). There are no conservation recommendations associated with this proposed action.

15 Reinitiation Notice

This concludes formal consultation for the NMFS Endangered Species Conservation Division’s issuance of an ITP for electrofishing surveys by MBI. Consistent with 50 C.F.R. §402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(1) The amount or extent of taking specified in the incidental take statement 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 previously considered.
(3) The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion.
(4) A new species is listed or critical habitat designated under the ESA that may be affected by the action.

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