ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Action Agency:	National Marine Fisheries Service, Northeast Fisheries Science Center, and National Marine Fisheries Service, Office of Protected Resources
Activity:	Endangered Species Act Section 7 Consultation on the Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals Pursuant to those Research Activities **PCTS ID: NER-2015-12532** **ECO ID: GARFO-2015-00029**
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1.0 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.), requires each Federal agency to insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of the designated critical habitat of such species. When the action of a Federal agency may affect a species or critical habitat that is protected under the ESA, that agency is required to consult with either the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the species and/or critical habitats that may be affected. In instances where the NMFS or USFWS authorizes, funds, or carries out an action that may affect ESA-listed species or critical habitat under their respective jurisdictions, the agency in question must conduct intra-service consultation.

The proposed Federal actions described in this document are fisheries and ecosystem research conducted and funded by the NMFS Northeast Fisheries Science Center (NEFSC) over a five-year period. Some of the projects proposed to be conducted or funded by the NEFSC utilize fishing gears, equipment, or active acoustic sources with the potential to incidentally take marine mammals. Those activities must also be authorized by the NMFS Office of Protected Resources (OPR) through the issuance of a Marine Mammal Protection Act (MMPA) letter of authorization (LOA). As a result of these two interrelated sets of Federal actions, we have been requested and are required to perform an intra-service section 7 consultation to assess their impacts on ESA-listed species and critical habitats under our jurisdiction, across the full range of activities and locations where they are proposed to occur.

As stated in its May 8, 2015, request for formal section 7 consultation, the NEFSC is serving as the lead action agency. This is because it is proposing to conduct and fund the fisheries and ecosystem research activities discussed herein, all of which were identified as the *primary* Federal action in its December 2014 draft programmatic environmental assessment (DPEA) (NEFSC 2014). As a result, the NEFSC assumes all responsibilities of that designation. Several of the proposed research activities also require an LOA from the OPR for the potential incidental take of marine mammals protected under the MMPA. The LOA issuance by the OPR for a five-year period is also part of the proposed actions, and has been identified in the DPEA as the *secondary* Federal action (NEFSC 2014). Therefore, on July 15, 2015, shortly following the publication of a proposed rule on its LOA in the *Federal Register*, the OPR also requested formal section 7 consultation and is serving as a cooperating agency.

As indicated and described in detail in the DPEA, the NEFSC's proposed actions are to conduct and fund a wide range of fisheries and ecosystem research activities annually as part of its mission. This includes both fishery-independent and industry-associated research and survey programs. Primary research activities include: bottom trawl surveys to support assessments of multiple groundfish and shrimp species as well as the status of benthic habitats; pelagic trawl surveys to assess Atlantic herring stocks; dredge and video camera surveys to assess scallop, surfclam, and ocean quahog stocks and scallop habitat recovery; longline and gillnet surveys to research life history parameters and abundance of numerous shark species; and extensive cooperative research projects designed to address current or emerging information needs of the commercial fishing industry such as bycatch reduction efforts and development of new fisheries. Many of the NEFSC's proposed research activities also include active acoustic systems, plankton nets, and other oceanographic equipment that provide important data on the status and trends of marine ecosystems important for various fisheries and natural resource management processes.

We, the NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (GARFO PRD), have most recently completed formal consultations and issued biological opinions (Opinions) pursuant to section 7 of the ESA for the following NEFSC research activities, which will continue largely along the same protocols over the next five years: (1) Penobscot Estuarine Fish Community and Ecosystem Survey (Opinion date: April 25, 2012), (2) NEFSC research vessel surveys (Opinion date: November 30, 2012), and (3) Northeast Area Monitoring and Assessment Program (NEAMAP) surveys (Opinion date: May 28, 2013). In both recent and prior Opinions for these three research programs, we have concluded that each may adversely affect, but is not likely to jeopardize the continued existence of ESA-listed species. We also concluded in the three Opinions that none of those research projects is likely to destroy or adversely modify designated critical habitat for ESA-listed species. In regards to other, usually smaller-scale projects previously conducted or funded by the NEFSC (e.g., cooperative research), we have generally covered those activities either through separate informal section 7 consultations (for those actions that are not likely to adversely affect listed species or designated critical habitat) or reinitiation reviews under specific fishery management plan (FMP) Opinions in which the fishing effort is conducted aboard a commercial vessel and already allocated to the fishery through annual specifications or shares of the quota. Through the issuance of this new programmatic Opinion, we will analyze the effects of all proposed fisheries and ecosystem research activities to be conducted and funded by the NEFSC over a five-year period, including the three programs described above as well as the separate smaller-scale projects, and withdraw the previous three Opinions listed above.

This programmatic Opinion is based on: (1) information contained in the NEFSC's December 2014 DPEA, (2) the OPR's 2015 proposed rule and request for consultation on the LOA (including revised acoustic take estimate calculations for sperm whales from September 2015), (3) information on past interactions with ESA-listed species provided by the NEFSC and its research partners, and (4) other scientific data and reports cited throughout this document. We also used information from past Opinions and environmental documents that were completed for the more continuous, larger-scale projects since 2007. A complete administrative record of this formal programmatic section 7 consultation will be kept on file at the GARFO PRD.

2.0 CONSULTATION HISTORY

2.1 Prior Formal Consultations on Actions Conducted and Funded by the NEFSC

Since 2007, we have formally consulted on the effects of fisheries and ecosystem research conducted and funded by the NEFSC on multiple occasions. These included Opinions on the NEFSC fisheries research vessel surveys, fisheries sampling surveys in the Penobscot River estuary, and the NMFS-funded spring and fall NEAMAP surveys conducted by the Virginia Institute of Marine Science (VIMS).

On August 20, 2007, we completed formal consultation on the NEFSC's research vessel activities, including bottom trawl and scallop dredge research utilizing the NOAA ships *Albatross IV*, *Delaware II*, *Gloria Michelle*, *Hugh R. Sharp*, and *Henry B. Bigelow*, for the period of January 1, 2007, to December 31, 2009. The resulting Opinion concluded that the NEFSC research vessel activities from 2007-2009 were likely to adversely affect, but not jeopardize the continued existence of loggerhead, leatherback, Kemp's ridley, or green sea turtles. Previously, these incidental takes of sea turtles were covered under the NEFSC's ESA section 10(a)(1)(A) permit (#1295) that allowed the take of up to five loggerhead, two green, two Kemp's ridley, one hawksbill, and one leatherback sea turtles per year. However, policy changes within NMFS at that time no longer allowed those incidental takes to be covered under the section 10(a)(l)(A) permit, as those permits are intended for directed research that targets ESA-listed species. The fisheries surveys conducted by the NEFSC, which were not targeting ESA-listed species, were thus required to undergo section 7 consultation as activities carried out by a Federal agency. Formal consultation on the NEFSC research vessel surveys was most recently completed on November 30, 2012, to account for gear interactions with sea turtles as well as newly listed distinct population segments (DPSs) of Atlantic sturgeon (77 FR 5880 and 77 FR 5914, February 6, 2012) during surveys conducted in 2013 and beyond. That Opinion exempted the annual incidental take of up to ten loggerheads (one lethal), two Kemp's ridleys (one lethal), one green, and one leatherback sea turtle as well as no more than 16 Atlantic sturgeon. These takes were anticipated to occur during the NEFSC's spring and fall bottom trawl surveys aboard the *Henry B. Bigelow*, the NEFSC's scallop dredge survey aboard the *Hugh R. Sharp*, or the Massachusetts Division of Marine Fisheries (MADMF) spring and fall bottom trawl surveys aboard the *Gloria Michelle* (NMFS 2012a).

On September 19, 2008, we completed consultation on the adverse effects of the fall 2008 NEAMAP survey on loggerhead sea turtles. The fall 2008 survey was the first NEAMAP survey to be funded under the Mid-Atlantic Research Set Aside (RSA) Program, which is authorized through the NEFSC. On April 16, 2009, we completed consultation on the adverse effects of the spring and fall 2009 surveys on loggerhead sea turtles. On April 13, 2010, we completed consultation on the adverse effects of the spring and fall 2010-2012 surveys on loggerhead as well as leatherback, Kemp's ridley, and green sea turtles. Most recently, on May 28, 2013, we released an updated Opinion to account for adverse effects of the spring and fall surveys in 2013 and beyond on the above species of sea turtles as well as the five listed Atlantic sturgeon DPSs. That Opinion exempted the annual incidental take of up to six loggerhead, four Kemp's ridley, one green, and one leatherback sea turtle as well as no more than 32 Atlantic sturgeon in the spring and fall NEAMAP surveys (NMFS 2013a). Since that Opinion, we have been notified that the annual levels of incidental take exempted for two species have been exceeded (Kemp's ridleys in 2013 and 2014, Atlantic sturgeon in 2014). Therefore, we will be reassessing the effects of the NEAMAP surveys on both sea turtles and Atlantic sturgeon in this new Opinion.

In 2010, the NEFSC conducted a pilot scale feasibility study to explore beach seining and fyke netting in limited areas of the Penobscot River. Consultation on the effects of the pilot study was completed in August 2010 and determined that the proposed action was not likely to adversely affect shortnose sturgeon. A more recent Opinion was issued on March 28, 2011, which analyzed the effects of research activities in 2011 and provided incidental take authorization for shortnose sturgeon. Most recently, we completed formal section 7 consultation regarding the effects of the proposed ecosystem survey to be conducted from 2012-2016 in the Penobscot River on April 25, 2012. That Opinion concluded that the proposed action was likely to adversely affect, but would not jeopardize the continued existence of both shortnose sturgeon and Atlantic sturgeon DPSs. That Opinion exempted the incidental take of up to 32 shortnose sturgeon (one lethal) and 15 Atlantic sturgeon (one lethal) in the beach seine, fyke net, and trawl gear components of the project over five years (NMFS 2012b).

2.2 Programmatic Formal Consultation for NEFSC Research Activities

In spring 2008, the NMFS Science Board asked the Office of Science and Technology to establish a working group to develop and implement a process to document how much incidental take of protected species was occurring by NMFS-supported survey activities. Although mechanisms exist in both the ESA and MMPA to assess the effects of incidental take and to authorize appropriate levels of take, NMFS Science Centers' use of these mechanisms had been inconsistent up to this point. The first phase of this national process to achieve full environmental compliance on NMFS's research activities included a data call to the Science Centers requesting information on takes of protected species during the past five years. The analysis of this information was intended to serve as the basis for issuing the appropriate authorizations to the Science Centers by the OPR. Additionally, each Science Center was required to work with their Regional Offices' National Environmental Policy Act (NEPA) Coordinators to develop the required NEPA documentation and other consultations under the ESA and MMPA to support their applications for an LOA in the course of pursuing their fisheries research. Given the complexity of this task, especially from the national perspective, and to encourage consistency of NEPA documents across regions, the National Regional NEPA Coordinators were tasked to work closely with their Science Center staff to develop the required documentation for the authorization process.

In June 2010, NMFS initiated the development of NEPA documents for individual Science Centers. Shortly thereafter, the NEFSC began to work through the process of gathering the necessary information and generating the DPEA to support their environmental compliance effort. Over the course of the next four and a half years, a process of draft, review, discussion, coordination, and revision of documents and analytical methodologies ensued, involving various staff and managers from offices all across NMFS. Given that the NEFSC was the second Science Center to progress towards a completed DPEA and application for an LOA, many issues that were understood or assumed to have some impact on how the overall national effort from NMFS would progress had to be resolved. Notably amongst those was the overall framework for development and presentation of the DPEA, the rationale used to estimate future incidental takes of marine mammals and Atlantic salmon during research activities, and analytical approaches used to calculate potential harassment of marine mammals from acoustic sources.

Since the early stages of this effort, the agency has been aware of the need to consult under section 7 of the ESA on the entire research program of the NEFSC, as well as the issuance of any authorizations under the MMPA to the NEFSC. The GARFO PRD was given the responsibility for handling the ESA section 7 consultation for both actions. As the process of developing the DPEA and LOA application unfolded, numerous informal calls, emails, and exchanges of information between staff from the NEFSC, OPR, and GARFO PRD occurred. The GARFO

PRD was able to provide input into the development of the DPEA to support initiation of formal consultation when these actions, and the MMPA process in particular, were fully developed.

The notice of receipt of an LOA application and DPEA for the NEFSC research programs was published in the *Federal Register* on December 29, 2014 (79 FR 78061; 79 FR 78065). On January 28, 2015, the NEFSC received comments on both the LOA application and DPEA from the Humane Society of the U.S and the Whale and Dolphin Conservation Society. On May 8, 2015, the NEFSC sent a letter to the GARFO PRD requesting that PRD staff initiate formal consultation under section 7(a)(2) of the ESA. On July 9, 2015, the GARFO PRD sent a letter to the NEFSC (and also copied the OPR) indicating that GARFO staff had reviewed the DPEA and other information and concluded that sufficient information was available to proceed with initiation under section 7 consultation. A proposed rulemaking on the LOA was also published by the OPR on July 9, 2015 (80 FR 39542). On July 15, 2015, the GARFO PRD received an ESA consultation initiation request from the OPR regarding the proposed issuance of the LOA, as published on July 9, 2015. In the ESA consultation initiation request, the OPR indicated that the LOA would be effective for a period of five years from the date of issuance.

During the remainder of 2015 and early 2016, several exchanges between NEFSC, OPR, and GARFO PRD staff occurred to clarify and exchange information regarding the potential impacts of the NEFSC's research on ESA-listed species and environmental compliance measures to be put in place to minimize and monitor incidental take. On September 29, 2015, the OPR sent the GARFO PRD revised calculations for anticipated sperm whale acoustic takes resulting from sound sources to be used during the NEFSC's fisheries and ecosystem research, which differed from the original estimates put forth in the LOA proposed rule from July 2015. Following receipt and review of the new acoustic take estimates, the 135-day consultation clock was reset.

In January 2016, staff from the NEFSC brought up several concerns related to the Opinion and proposed LOA and suggested a workshop be held to get all stakeholders within the agency on the same page. The focus of the suggested workshop was to discuss mitigation and monitoring, data collection, and reporting requirements post-permit and Opinion issuance and the need for coordination, training, and communications as the NEFSC switched into implementation mode for upcoming field seasons. On February 29, 2016, a mini-workshop on environmental compliance and implementation involving staff from the NEFSC, OPR, and GARFO PRD was held at the NEFSC. The agenda of the workshop included discussion on the programmatic Opinion, the species to be addressed and for which take should be exempted, and the Reasonable and Prudent Measures (RPMs) and Terms and Conditions (T&Cs) to be included. Shortly after the mini-workshop, on March 18, 2016, the NEFSC sent comments to GARFO PRD on the proposed RPMs/T&Cs based upon feedback from staff in the Ecosystems Surveys, Protected Species, Fisheries Sampling, and Cooperative Research programs. Along with those comments, the NEFSC also submitted a request to the GARFO PRD to include Atlantic salmon take exemptions and coverage in the Opinion although not previously addressed in the DPEA or acknowledged by the GARFO PRD as a species likely to be adversely affected by the proposed action. At that point, the 135-day consultation clock was reset again. Based upon the latest initiation date of March 18, 2016, the GARFO PRD was required to complete formal consultation and issue a programmatic Opinion for this action by July 31, 2016, but indicated to the NEFSC and OPR that it would expedite the consultation and complete it by mid-June 2016.

This programmatic Opinion will replace the previously mentioned 2012 Opinion on the Penobscot Estuarine Fish Community and Ecosystem Survey, 2012 Opinion on the NEFSC research vessel surveys, and 2013 Opinion on the NEAMAP surveys. This new Opinion will provide ESA section 7 coverage for these and other NEFSC-sponsored fisheries and ecosystem research projects that may result in incidental take of ESA-listed species over a five-year period.

2.3 Other Associated Consultations (non-ESA)

An essential fish habitat (EFH) consultation has been conducted by the NMFS GARFO Habitat Conservation Division on the NEFSC's fisheries and ecosystem research activities, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600, and will be included as part of the final EA for this action. The EFH consultation concluded that impacts to EFH will be no more than minimal and temporary, and relied heavily on a calculation of the small amount of area swept by survey tows (trawls and dredges) that the NEFSC did for a previous EA. No new information has been provided that changes the analysis conducted during that EFH consultation and no additional EFH analysis will be provided in this Opinion.

The Stellwagen Bank National Marine Sanctuary, through the NMFS Office of National Marine Sanctuaries (ONMS), has also completed a consultation and associated environmental review of fisheries and ecosystem research conducted and funded by the NEFSC. This was in response to a research permit and application sent by the NEFSC to the ONMS on November 16, 2015. On April 1, 2016, the ONMS issued a research permit to the NEFSC (SBNMS-2015-003), which is effective from April 1, 2016, until January 31, 2021. The research permit allows the NEFSC to conduct bottom-tending research trawls in Sanctuary waters, with the exception of identified "Areas to Avoid" and five long-term monitoring sites, for the purpose of assessing the status and trends of fishery resources.

3.0 DESCRIPTION OF THE PROPOSED ACTIONS

The NEFSC is the research arm of the NMFS in the Greater Atlantic (formerly, the Northeast) Region. The NEFSC plans, develops, and manages a multidisciplinary program of basic and applied research to:

- better understand living marine resources of the Northeast Continental Shelf Large Marine Ecosystem (NE LME) from the Gulf of Maine to Cape Hatteras, North Carolina, and the habitat quality essential for their existence and continued productivity;
- provide fishery independent survey data for management of sharks in the NE LME as well as the Southeast Continental Shelf Large Marine Ecosystem (SE LME) to encompass the range of the surveyed species; and
- describe and provide to management, industry, and the public, options for the conservation and use of living marine resources, and for the restoration and maintenance of marine environmental quality.

Since 1963, the NEFSC has conducted research surveys from the Gulf of Maine south to Cape Hatteras. Additionally, shark longline surveys have been conducted between Florida and Rhode

Island in both coastal and estuarine waters to encompass the range of the surveyed species and opportunistic juvenile pelagic shark work is conducted as far north as the Grand Banks off Newfoundland, Canada. These surveys, described in greater detail below, in Appendices A and B, and in the December 2014 DPEA, are conducted to monitor for important indicators of the overall health and status of the region's fisheries resources such as recruitment, abundance and survival of harvestable sizes, geographic distribution of species, ecosystem changes, biological rates of stocks, and environmental data to support other research.

The proposed actions include both short- and long-term research activities conducted by the NEFSC or its research partners that involve:

- the deployment of fishing gear and scientific instruments into the water in order to sample and monitor living marine resources and their environmental conditions,
- active acoustic devices for navigation and remote sensing,
- the transiting of research vessels through the marine waters of the Atlantic Ocean, and
- observational surveys made from the deck of those vessels (e.g., marine mammal and seabird transects).

It should be noted that the proposed actions only include activities that may affect ESA-listed species of marine mammals, sea turtles, and fish. In addition, the research activities covered in this Opinion only include those resulting in *incidental* interactions with listed species, not *intentional* interactions. Any research activities conducted or funded by the NEFSC that directly study, sample, or capture ESA-listed species (e.g., Atlantic salmon trawl surveys, Atlantic Marine Assessment Program for Protected Species [AMAPPS] surveys) are not included in this Opinion. Directed take of ESA-listed species as a result of those types of activities must instead be assessed in and covered under an ESA section 10 permit. The primary focus of this Opinion is on fisheries-related research, but several other types of surveys are also included because they deploy fishing gear and other instruments similar to those used in fisheries research, and therefore involve the same potential risks of incidental interactions with ESA-listed species.

3.1 Fisheries and Ecosystem Research Conducted and Funded by the NEFSC

As discussed above, the NEFSC collects a wide array of information necessary to evaluate the status of fishery resources and the marine environment. NEFSC scientists conduct fishery-independent research onboard NOAA owned and operated vessels or on chartered vessels in the NE and SE LMEs, an area of the Atlantic Ocean stretching from the U.S.-Canada border to Florida. In recent years, the NEFSC has used the fishery survey vessels *Henry B. Bigelow* and *Pisces*; the fishery research vessels *Hugh R. Sharp* and *Gloria Michelle*, the NOAA Ships *Gordon Gunter*, *Thomas Jefferson*, and *Okeanos Explorer*; and multiple charter vessels.

As proposed, the NEFSC would administer and conduct a wide range of fishery-independent and industry-associated research and survey programs as they have been in the recent past, as summarized in Table A-1 of Appendix A, in addition to several new research surveys and projects, as summarized in Table A-2 of Appendix A. It should be noted that several long-term surveys and projects that have occurred previously will not be continued under the proposed action. Those surveys include the Apex Pelagic Shark longline survey (Maryland to Canada), Ecosystem Monitoring survey (proposed to be expanded and renamed as the Northeast Integrated

Pelagic Survey), and the Estuarine Habitat Dynamics and Telemetered Movements (a small tagging project in New Jersey). As a result, no coverage is necessary for those past studies and they will not be addressed further. Appendix A of the NEFSC's 2014 DPEA provides an illustrated description of the fishing gear and scientific instruments used during NEFSC research.

Several new long-term surveys and short-term cooperative research projects are also included as part of the proposed action. The cooperative research projects are designed to address emerging needs of the fishing industry for information about particular species or modifications to fishing gear to address conservation concerns. They are typically funded through competitive grant processes that entertain new research proposals every year. The exact scientific focus and research procedures for future proposals cannot be anticipated. However, the proposed action assumes that similar types of projects will be proposed and funded in the future. The NEFSC has estimated the types of fishing gear and level of effort required to accommodate future requests for short-term cooperative research projects. This level of fishing effort will be considered, along with the long-term projects described below, as the collective level of research activities under the proposed action. Future proposals for funding and other support for cooperative research will be compared to the scope of research analyzed in this Opinion to assess whether the projects are consistent with the analysis presented here.

In addition to the long-term research activities conducted aboard research and contract vessels, which are summarized in Appendix A, the proposed action includes a set of fisheries and ecosystem research activities which fall predominately under the category of Cooperative Research, which in the Greater Atlantic Region is made up of several programs summarized below: Cooperative Research Partners Program, Northeast Consortium Cooperative Research Program, Commercial Fisheries Research Foundation, and the Research Set-Aside Program.

- ***Cooperative Research Partners Program –*** In Fiscal Year (FY) 1999, NMFS GARFO developed the Cooperative Research Partners Program (CRPP), formerly known as the Cooperative Research Partners Initiative, to formalize and expand collaborative research among New England's commercial fishing industry, marine science and fishery management communities. The goal of this initiative is to enhance the data upon which fishery management decisions are made as well as to facilitate communication and collaboration among New England commercial fishermen, scientists, and fishery managers. Through this initiative, CRPP partners are collaborating with the New England Fishery Management Council (NEFMC) in setting research priorities to meet management and fishing industry needs.

- ***Northeast Consortium Cooperative Research Program –*** The Northeast Consortium administers nearly $5 million annually from the NEFSC for collaborative research on a broad range of topics that are consistent with the mission of the NEFSC, including gear selectivity, fish habitat, stock assessments, and socioeconomics. The funding is appropriated to NMFS and administered by the University of New Hampshire on behalf of the Northeast Consortium. Potential research projects are solicited through an annual Request for Proposals and funds are distributed through an open competition after scrutiny of research protocols by an institutional board of review. All projects must involve partnership between commercial fishermen and scientists, be designed to minimize any negative impacts to ecosystems or marine organisms, and be consistent with accepted ethical research practices.

- ***Commercial Fisheries Research Foundation –*** The Commercial Fisheries Research Foundation is designed to support 1-2 year research projects that address a range of topics: gear engineering aimed at bycatch reduction and compliance with protected species regulations; reproductive capabilities and discard mortality rates for key species; and evaluation of the socio-economic impacts of fishery management regulations. The Commercial Fisheries Research Foundation administers the program based on the "Strategic Plan for Collaborative Fisheries Research in Southern New England" (CFRF 2011). The research projects are conducted primarily by academic institutions. Future funding will be devoted to supporting collaborative research projects in the areas of improved stock assessments, bycatch reduction (particularly in the winter flounder fishery), understanding of changing ecosystem dynamics as they relate to the rebuilding of fisheries stocks important to Rhode Island and southern New England, and the socio economic impacts of fishery regulations.

- ***Research Set-Aside Programs –*** Research Set-Aside programs (RSAs) were developed by the NEFMC and the Mid-Atlantic Fishery Management Council (MAFMC) as part of the FMP process, and are administered by NMFS. RSA programs encourage cooperative research among fisheries participants, marine scientists, and fishery managers. The goals of the RSA programs are to further the understanding of our nation's fisheries, enhance information used in fisheries management decision-making, and foster collaborations among marine fisheries interests. RSA programs are implemented in accordance with individual FMPs. Some FMPs set aside a portion of the annual fishery-wide quota or Total Allowable Catch (TAC) to be harvested for the purpose of funding research. FMPs such as those for sea scallops and Atlantic herring in New England, and summer flounder, scup, black sea bass, tilefish, spiny dogfish, *Illex* squid, *Loligo* squid, butterfish, Atlantic mackerel, and bluefish in the Mid-Atlantic reserve up to 2-3% of the TAC, depending on the fishery, for research funding. The monkfish FMP sets aside a portion of the days-at-sea (DAS) allocated for fishing to establish an annual pool of research DAS. A vessel that participates in an approved research project may apply for research DAS instead of using valuable fishing time to participate in cooperative monkfish research. Currently, RSA programs have been implemented for Atlantic Sea Scallops, Mid-Atlantic multi-species, Monkfish, and Atlantic Herring FMPs.

The specific projects funded through these programs vary on an annual basis as needs arise for information to support particular fisheries or address emerging conservation concerns. Table B-1 in Appendix B provides a summary of the projects that have been supported by the NEFSC from 2008-2012, which is taken as a period representing the Status Quo baseline. The number of Cooperative Research projects undertaken or funded by the NEFSC from 2008-2012 (a total of 51), which will serve as an indicator of the number of projects anticipated over the five-year period to be assessed in this Opinion, is broken down as follows:

- 8 <u>Survey</u> projects (three trawl, one dredge, two hook and line, and two pot gear projects);
- 26 <u>Conservation Engineering</u> projects (19 trawl, one dredge, one hook and line, two gillnet, and three "other" gear projects);

- 5 Tagging projects (two trawl, two hook and line, and one gillnet gear projects);
- 11 Life History projects (three trawl, five pot, and three "other" gear projects); and
- 1 Habitat project (dredge gear).

Given our past experience with and knowledge of the usual applicants and partners (and where/ when they fish), we expect that future Cooperative Research projects would propose fishing types, ecosystem research equipment, and associated fishing effort similar to previous projects conducted or funded by the NEFSC from 2008-2012 and, therefore, not introduce a significant increase in effort levels for the overall proposed action considered in this Opinion. As a result, the funding and carrying out of those Cooperative Research projects, if at a similar level and in similar areas, would be expected to fall within the level of effort and impacts considered in this Opinion. This includes all NEFSC-funded RSA projects which have been previously covered in FMP Opinions produced by the GARFO for the scallop, monkfish, bluefish, summer flounder/ scup/black sea bass, and squid fisheries (NMFS 2012c, 2013b). If a Cooperative Research project is proposed which modifies the proposed action in a manner that causes effects to ESA-listed species or critical habitat not considered in this Opinion, consultation will be reinitiated.

The short-term, cooperative research projects described in Table B-1 of Appendix B (which are part of the Status Quo Alternative identified in the DPEA) generally will not continue under the Preferred Alternative, although some of them may still be in progress or may continue under somewhat different configurations. The NEFSC has estimated the types of fishing gear and level of effort required to accommodate future requests for short-term cooperative research projects, as summarized in Table B-2 in Appendix B. This level of fishing effort will be considered, along with the long-term projects described in Tables A-1 and A-2 of Appendix A, as the collective level of research activities under the Preferred Alternative. Future proposals for funding and other support for cooperative research will be compared to the scope of research described in these three tables to assess whether the projects are consistent with the programmatic Opinion as well as the NEPA analysis in the DPEA.

3.2 Regulations and a Letter of Authorization to Permit Marine Mammal Takes

Under this action, the NEFSC has applied for an authorization under the MMPA for incidental take of marine mammals during these research activities. The OPR has considered the proposed fisheries and ecosystem research activities and corresponding mitigation measures for marine mammals and has proposed to promulgate regulations and issue an LOA as appropriate to the NEFSC. Through the NMFS Permits and Conservation Division, the OPR proposes to issue regulations and a LOA to the NEFSC, pursuant to section 101(a)(5)(A) of the MMPA of 1972, as amended (16 U.S.C. 1361 *et seq.*), for the taking of both ESA- and MMPA-listed marine mammals incidental to fisheries and ecosystem research in the Atlantic Ocean over the course of five years. The LOA would be effective for a period of five years from the date of issuance.

The Permits and Conservation Division published a proposed rule in the *Federal Register* on July 9, 2015, related to the authorization of take incidental to the NEFSC's fisheries and ecosystem research activities over a five-year period (80 FR 39542). Once the regulations are promulgated and a final LOA is issued, they would prescribe the permissible methods of taking; a suite of mitigation measures intended to reduce the risk of potentially adverse interactions with marine mammals and their habitats during the specified research activities; and require reporting that will result in increased knowledge of the species and the level of taking.

Proposed mitigation measures and monitoring requirements for the NEFSC's proposed fisheries and ecosystem research activities are described in detail in the proposed rule and will include:

- Required monitoring of the sampling areas to detect the presence of marine mammals before deployment of pelagic trawl nets, pelagic or demersal longline gear, bottom-contact trawls, gillnets, dredge gear, fyke nets, and beach seines.
- Required implementation of standard tow durations of not more than 30 minutes to reduce the likelihood of incidental take of marine mammals.
- Required implementation of the mitigation strategy known as the "move-on rule," which incorporates best professional judgment, when necessary during pelagic trawl and pelagic longline operations.
- Required compliance with applicable vessel speed restrictions.
- Required compliance with applicable and relevant take reduction plans for marine mammals.

The NEFSC has not requested, and does not propose, to authorize MMPA Level A take (i.e., serious injury/mortality) for any ESA-listed marine mammal species within the action area. However, they do propose to authorize MMPA Level B take (i.e., harassment) incidental to the use of active acoustic sources for ESA-listed sperm whales. A wide range of active acoustic sources are used in the NEFSC’s fisheries and ecosystem research for remotely sensing bathymetric, oceanographic, and biological features of the environment. Most of these sources involve relatively high frequency, directional, and brief repeated signals tuned to provide sufficient focus and resolution on specific objects. Only two sound sources used by the NEFSC are likely to produce underwater noise levels that may result in acoustic harassment to ESA-listed sperm whales: the Simrad EK60 and Simrad ME70 sounders. Important characteristics of these two acoustic sources are provided below in Table 1, followed by more detailed descriptions. The other predominant sound sources used by the NEFSC are described in more detail in the 2014 DPEA, but those will not be addressed here as they do not operate at sound levels known to adversely affect ESA-listed marine mammals, sea turtles, or fish.

Table 1. Characteristics for the two NEFSC active acoustic sources assessed in this Opinion.

Active Acoustic System (product name and #)	**Operating frequencies (kHz)**	**Maximum source level (dB re 1 µPa at 1 m)**	**Nominal beam width (degrees)**
Simrad EK60 Narrow Beam Scientific Echo Sounder	38, 70, 120, 200	224	11@18kHz; 7@38kHz
Simrad ME70 Multi-Beam Echo Sounder	70-120	205	140

Multi-frequency Narrow Beam Scientific Echo Sounder (Simrad EK60 – 38, 70, 120, 200 kHz)
Similar to multibeam echosounders, multi-frequency split-beam sensors are deployed from NOAA survey vessels to acoustically map the distributions and estimate the abundances and biomasses of many types of fish; characterize their biotic and abiotic environments; investigate ecological linkages; and gather information about their schooling behavior, migration patterns, and avoidance reactions to the survey vessel. The use of multiple frequencies allows coverage of a broad range of marine acoustic survey activity, ranging from studies of small plankton to large fish schools in a variety of environments from shallow coastal waters to deep ocean basins. Simultaneous use of several discrete echosounder frequencies facilitates accurate estimates of the size of individual fish, and can also be used for species identification based on differences in frequency-dependent acoustic backscattering between species. The NEFSC uses devices that transmit and receive at four frequencies ranging from 38 to 200 kHz.

Multi-beam echosounder (Simrad ME70 – 70-120 kHz)
Multibeam echosounders and sonars work by transmitting acoustic pulses into the water then measuring the time required for the pulses to reflect and return to the receiver and the angle of the reflected signal. The depth and position of the reflecting surface can be determined from this information, provided that the speed of sound in water can be accurately calculated for the entire signal path. The use of multiple acoustic 'beams' allows coverage of a greater area compared to single beam sonar. The sensor arrays for multibeam echosounders and sonars are usually mounted on the keel of the vessel and have the ability to look horizontally in the water column as well as straight down. Multibeam echosounders and sonars are used for mapping seafloor bathymetry, estimating fish biomass, characterizing fish schools, and studying fish behavior. The multibeam echosounders used by NEFSC are mounted to the hull of the research vessels and emit frequencies in the 70-120 kHz range.

3.3 Action Area

The action area for section 7 consultations is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR 402.02). We anticipate that the effects on ESA-listed species and their habitats as a result of the proposed actions include the direct effects of interactions between listed species and the fishing gear that will be used for these studies (i.e., trawls, gillnets, dredges, hook and line gear, and pot/trap gear) as well as the effects on other marine organisms (i.e., prey) on or very near to the sea floor that may result from direct capture in the gear. In addition, indirect effects from the operation of the research and fishing vessels on ESA-listed species, their prey, and habitats are possible. Therefore, for the purpose of this consultation, the action area is defined by the area in which various research and fishing vessels will be conducting study activities and the areas they will be transiting through. Broadly defined, this includes all U.S. Exclusive Economic Zone (EEZ) waters in the Northwest Atlantic Ocean (including nearshore bays, estuaries, and river mouths) from the U.S./Canada border to Key West, Florida; although the vast majority of NEFSC fisheries and ecosystem research activities will only range as far south as Cape Hatteras.

4.0 STATUS OF LISTED SPECIES AND CRITICAL HABITAT

Several ESA-listed species under NMFS jurisdiction occur in the action area for this consultation. We have determined that the actions being considered in this Opinion may affect the following ESA-listed species in a manner that will likely result in adverse effects:

Common name	Scientific name	ESA Status
Sperm whale	*Physeter macrocephalus*	Endangered
Loggerhead sea turtle - NWA DPS[1]	*Caretta caretta*	Threatened
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Green sea turtle - North Atlantic DPS[2]	*Chelonia mydas*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	
Gulf of Maine (GOM) DPS		Threatened
New York Bight (NYB) DPS		Endangered
Chesapeake Bay (CB) DPS		Endangered
Carolina DPS		Endangered
South Atlantic (SA) DPS		Endangered
Atlantic salmon - Gulf of Maine DPS	*Salmo salar*	Endangered

We have determined that the actions being considered in this Opinion are not likely to adversely affect hawksbill sea turtles (*Eretmochelys imbricata*), North Atlantic right whales (*Eubalaena glacialis*), humpback whales[3] (*Megaptera novaengliae*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), or blue whales (*Balaenoptera musculus*), all six of which are listed as endangered under the ESA. We have also determined that the proposed actions are not likely to adversely affect critical habitat found in the action area for North Atlantic right whales, the NWA DPS of loggerhead sea turtles, or the Gulf of Maine DPS of Atlantic salmon. The following discussions are our rationale for these determinations.

4.1 Species Not Likely to be Adversely Affected by the Proposed Action

The hawksbill sea turtle is listed as endangered. This species is uncommon in the waters of the continental U.S. Hawksbills prefer coral reef habitats, such as those found in the Caribbean and Central America. Mona Island (Puerto Rico) and Buck Island (St. Croix, U.S. Virgin Islands) contain especially important foraging and nesting habitat for hawksbills. Within the continental U.S., nesting is restricted to the southeast coast of Florida and the Florida Keys, but nesting is rare in these areas. Hawksbills have been recorded from all Gulf of Mexico states and along the U.S. east coast as far north as Massachusetts, but sightings north of Florida are rare. Many of the strandings in states north of Florida have been observed after hurricanes or offshore storms. Aside from Florida, Texas is the only other U.S. state where hawksbills are sighted with any

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[1] NWA DPS = Northwest Atlantic DPS, the only loggerhead sea turtle DPS expected to occur in the action area.
[2] The North Atlantic DPS is the only green sea turtle DPS expected to occur in the action area.
[3] On April 21, 2015, NMFS published a proposed rule (80 FR 22303) to change the ESA listing of humpback whales. After an extensive scientific status review, NMFS identified 14 DPSs of humpback whales: two are proposed as threatened, two as endangered, and ten as not warranted for listing. The DPS found in U.S. Atlantic waters, the West Indies DPS, is proposed to be delisted. For that population, the MMPA requirements are sufficient.

regularity. Since hawksbill sea turtles are not expected to be present in the vast majority of areas where the NEFSC's fisheries and ecosystem research will occur, impacts to this species as a result of the proposed actions are discountable. The lack of any captures of hawksbill sea turtles in any NEFSC conducted or funded project to date supports this determination. The only recorded capture of a hawksbill sea turtle during a NMFS fisheries research project was in a bag seine during a Southeast Fisheries Science Center (SEFSC) shellfish survey off Texas in 2009.

Federally endangered North Atlantic right whales, humpback whales, fin whales, sei whales, and blue whales are known to occur in areas where the proposed action will occur. However, none of these species are expected to be affected by the use of gears or active acoustic sources used in the NEFSC's proposed fisheries and ecosystem research given the following. While these species may occur in the action area, large whales have the speed and maneuverability to get out of the way of oncoming mobile gear, including trawl, dredge, and hook and line gear. The slow speed of the mobile gears being towed and the short tow times to be implemented further reduce the potential for entanglement or any other interaction. Observations of many fishing trips and surveys using mobile gear have shown that entanglement or capture of large whales in these gear types is extremely rare and unlikely. The use of other gear types known to be more detrimental to large whales (e.g., gillnets and pot/trap gear) will be minimal compared to the use of mobile gear and monitored regularly over short set times. As a result, we have determined that it is extremely unlikely that any large whale would interact with the gear types being used during the proposed actions, making impacts to these species discountable. In regards to the NEFSC's use of active acoustic sources, the potential for harassment of these five large whale species is insignificant as the frequencies emitted by the two predominant sources to be used (the Simrad E60 and ME70 sounders) are not known to cause adverse effects to these species. This will be discussed further in the LOA final rule, which will be published in the Federal Register shortly after the release and signature of this Opinion.

We have determined that the actions being considered in the Opinion are not likely to adversely modify or destroy designated critical habitat for North Atlantic right whales. This determination is based on the actions' effects on the conservation value of the habitat that has been designated. Specifically, we considered whether the actions were likely to affect the physical or biological features that afford the designated area value for the conservation of North Atlantic right whales. On January 27, 2016, NMFS published a final rule (81 FR 4838) to replace the critical habitat for right whales in the North Atlantic originally designated in 1994 with two new areas. The final rule became effective on February 26, 2016. The areas newly designated as critical habitat contain approximately 29,763 square nautical miles of marine habitat in the Gulf of Maine and Georges Bank region (Unit 1, Northeastern U.S. Foraging Area) and off the Southeast U.S. coast (Unit 2, Southeastern U.S. Calving Area).

The final rule identifies the following four physical and biological features of the Northeastern U.S. foraging habitat that are essential to the conservation of the species: (1) the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate *Calanus finmarchicus* for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes; (2) low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; (3) late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and (4) diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region. The Northeastern U.S. foraging habitat, which is located within the action area, has been designated as critical habitat for right whales due to its importance as a spring/summer foraging ground for the species. What makes this area so critical, as indicated above, is the presence of dense concentrations of copepods. None of the gear types used in the proposed actions will affect the availability of copepods for foraging right whales because copepods are very small organisms that will pass through the fishing gear rather than being captured in it. In addition, the proposed actions will not affect the oceanographic conditions in the Gulf of Maine which serve to concentrate the copepods.

Nearshore waters off southern North Carolina, South Carolina, Georgia, and northeastern Florida have been designated as critical habitat for right whales due to their importance as winter calving and nursery grounds for the species. The environmental features that have been correlated with the distribution of right whales in these waters include preferred water depths and water temperature (Keller *et al*. 2012). Currently there is no evidence that the NEFSC's fisheries and ecosystem research and its associated gear types are likely to impact water depth, water temperature, or distance from shore.

Since the proposed actions are not likely to affect the physical and biological features that characterize both the feeding and calving habitat for North Atlantic right whales, these actions are not likely to adversely affect designated critical habitat for the species. Therefore, North Atlantic right whale critical habitat will not be considered further in this Opinion.

We have also determined that the proposed action will not have any adverse effects on the availability of prey for right, humpback, fin, sei, and blue whales. Right and sei whales feed on copepods. As indicated above, the gears to be used will not affect the availability of copepods for foraging sei whales because copepods are very small organisms that will pass through the fishing gear rather than being captured in it. Humpback, fin, and blue whales feed on krill as well as small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002; Clapham 2002; Sears 2002). The total prey removal by all NEFSC fisheries research surveys and projects, regardless of season and location in the Atlantic coast region, totals a few hundreds of tons of fish per year, which is a negligible percentage of the estimated fish consumed by large whales. The NEFSC research catch of invertebrate prey is also small; the average annual NEFSC research catch of long-finned squid was less than 12 tons (NEFSC 2014).

In addition to the small total biomass taken, some of the size classes of fish targeted in research surveys are smaller than that generally targeted by large whales. Research catches are also distributed over a wide area because of the random sampling design covering large sample areas. Fish removals by research are therefore highly localized and unlikely to affect the spatial concentrations and availability of prey for any large whale species. In the southern portion of the Atlantic coast region, NEFSC-affiliated fisheries research is primarily related to catch, tag, and release studies of sharks, with minimal numbers of finfish collected for lab analysis. This level of effort would have no impact on prey sources for large whales in southern portion of the Atlantic coast region. Therefore, the impacts on prey for humpback, fin, and blue whales are insignificant and the proposed action will not affect the availability of prey for these species.

In addition, the proposed action will not occur in low latitude waters where the overwhelming majority of calving and nursing occurs for these five large whale species (Aguilar 2002; Clapham 2002; Horwood 2002; Kenney 2002; Sears 2002). Therefore, the proposed action will not affect the oceanographic conditions that are conducive for calving and nursing.

We have determined that the actions being considered in the Opinion are not likely to adversely modify or destroy designated critical habitat for the NWA DPS of loggerhead sea turtles. On July 10, 2014, the USFWS and NMFS published two separate final rules in the Federal Register designating critical habitat for the NWA DPS of loggerhead sea turtles under the ESA (79 FR 39755 for nesting beaches under USFWS jurisdiction; 79 FR 39856 for marine areas under NMFS jurisdiction). Effective August 11, 2014, NMFS's final rule for marine areas designated 38 occupied areas within the at-sea range of the NWA DPS. These marine areas of critical habitat contain one or a combination of: nearshore reproductive habitat, overwintering habitat, breeding habitat, migratory habitat, and *Sargassum* habitat.

Fisheries research activities using fixed gear (e.g., gillnets and pots/traps) are a concern for loggerhead sea turtle critical habitat if the gear is arranged closely together within the designated migratory, overwintering, breeding, and nearshore reproductive habitats off the U.S. Atlantic coast, as those gears could result in altered habitat conditions needed for efficient passage of loggerheads through the areas (79 FR 39856). The NEFSC's fisheries and ecosystem research activities use the following gear types: trawls, gillnets, traps/pots, dredges, longlines, purse seines, weirs, rod and reel, and other hand gears (e.g., rakes, jigs, dip nets, spears). While these gears are known to be deployed within certain areas of the critical habitat for NWA DPS loggerheads, the occasional placement and wide-ranging operation of these gear types within the fisheries research surveys discussed here (per research protocols currently in place) is not expected to prevent the passage of loggerheads through the critical habitat areas or inhibit their usage of those areas. In regards to effects on benthic habitat in the designated critical habitat, there is no evidence that bottom trawls or any other types of gears used by the NEFSC's fisheries and ecosystem research surveys adversely affect sandy, muddy, or hard bottom habitats where NWA DPS loggerheads routinely forage and rest (NREFHSC 2002). In addition to the actions of setting and hauling gear, research and fishing vessel movements are not expected to significantly alter the physical or biological features of the critical habitat areas to levels that would affect life history patterns of individual turtles or the health of prey species found in these habitats. Previous formal consultations on the NEFSC's fisheries and ecosystem research surveys support the conclusion that effects to sea turtle habitats from fishing activities are insignificant and/or discountable (see NMFS 2012a, 2013a). Based on this information, we have determined that there will be no adverse effects to designated critical habitat for NWA DPS loggerheads from the NEFSC's research activities.

We have determined that the action being considered in this Opinion is not likely to adversely modify or destroy critical habitat that was designated for the Gulf of Maine DPS of Atlantic salmon on June 19, 2009 (74 FR 29300), and revised on August 10, 2009, to exclude trust and fee holdings of the Penobscot Indian Nation and a table was corrected (74 FR 39003; August 10, 2009). There is no Atlantic salmon critical habitat in the marine environment where the majority of the NEFSC's fisheries and ecosystem research activities will occur. For inshore and estuarine areas where the NEFSC will operate, a discussion of effects on critical habitat is included below.

The critical habitat designation for the Gulf of Maine DPS of Atlantic salmon consists of 45 specific areas that include approximately 19,571 kilometers of perennial river, stream, and estuary habitat and 799 square kilometers of lake habitat within the geographic area occupied by the Gulf of Maine DPS at the time of listing, and in which are found those physical and biological features essential to the conservation of the species. The entire occupied range of the Gulf of Maine DPS in which critical habitat is designated is within the State of Maine. Some of the estuarine research activities proposed by the NEFSC occur within designated critical habitat for listed Atlantic salmon.

The action area, albeit an extremely small portion of it in Maine, contains known migratory corridors for both juvenile and adult Atlantic salmon. A migratory corridor free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds or prevent emigration of smolts to the marine environment is identified in the critical habitat designation as essential for the conservation of Atlantic salmon. The Primary Constituent Elements (PCE) for designated critical habitat of listed Atlantic salmon in the action area are: 1) freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations; 2) freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation; and 3) freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

We have analyzed the potential impacts of the NEFSC's fisheries and ecosystem research on designated critical and PCEs in the action area. We have determined that the effects to these PCEs will be insignificant for the following reasons: the research activities will not result in a migration barrier as the surveys will only affect small portions of specific rivers and estuaries at any given time, and because no salmon will be prevented from passing through the action area. The research activities will not alter the habitat in any way that would increase the risk of predation, as all research in Maine rivers and estuaries will primarily involve low impact surface and mid-water trawls, hook and line gear, pot/trap gear, and possibly beach seines and fyke nets. There will be no water quality impacts from the proposed actions and therefore the research activities are not expected to affect water quality during salmon migrations in the action area. The research activities will not significantly affect the forage of juvenile or adult Atlantic salmon, as their prey are not normally the target of the fisheries and ecosystem research activities being undertaken (and if they are, they will be collected in small numbers with most being returned to the water soon after capture). Finally, as the proposed actions will not affect the natural structure of the nearshore habitat, since the gears and vessels to be used will only be there temporarily, there will be no reduction in the capacity of substrate, food resources, and natural cover to meet the conservation needs of Atlantic salmon. Based upon this reasoning, we have determined that any effects to designated critical habitat in the action area will be insignificant.

4.2 Species Likely to be Adversely Affected by the Proposed Action

This section will focus on the status of the various ESA-listed species likely to be adversely affected within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

4.2.1 Status of Sperm Whales

Sperm whales are the largest of the odontocetes (toothed whales) and the most sexually dimorphic cetaceans, with males considerably larger than females. Adult females may grow to lengths of 36 feet (11 meters) and weigh 15 tons (13,607 kilograms). Adult males, however, reach about 52 feet (16 meters) and may weigh as much as 45 tons (40,823 kilograms). The sperm whale is distinguished by its extremely large head, which takes up to 25-35% of its total body length. It is the only living cetacean that has a single blowhole asymmetrically situated on the left side of the head near the tip. Sperm whales are mostly dark gray, but oftentimes the interior of the mouth is bright white, and some whales have white patches on the belly. Their flippers are paddle-shaped and small compared to the size of the body, and their flukes are very triangular in shape. They have small dorsal fins that are low, thick, and usually rounded.

Distribution
Sperm whales are distributed in all of the world's oceans, from equatorial to polar waters, and are highly migratory. Mature males range between 70ºN in the North Atlantic and 70ºS in the Southern Ocean (Reeves and Whitehead 1997; Perry *et al*. 1999), whereas mature females and immature individuals of both sexes are seldom found beyond 50ºN or 50ºS (Reeves and Whitehead 1997). In winter, female sperm whales migrate closer to equatorial waters (Kasuya and Miyashita 1988; Waring 1993) where adult males presumably join them to breed.

In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the center of distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central portion of the Mid-Atlantic Bight and the southern portion of Georges Bank. In summer, the distribution is similar but also includes the areas east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100 meter isobath) south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest levels, and there remains a continental shelf edge occurrence in the Mid-Atlantic Bight.

While they may be encountered almost anywhere on the high seas, their distribution shows a preference for continental margins, sea mounts, and areas of upwelling where food is abundant (Leatherwood and Reeves 1983). Waring *et al.* (2005) suggested that sperm whale distribution is closely correlated with the Gulf Stream edge. Sperm whales migrate to higher latitudes during summer months, when they are concentrated east and northeast of Cape Hatteras. Bull sperm whales migrate much farther poleward than the cows, calves, and young males. Because most of the breeding herds are confined almost exclusively to warmer waters many of the larger mature males return in the winter to the lower latitudes to breed. Sperm whales in the Caribbean region appear to be much more restricted in their movements, with individuals repeatedly sighted within less than 160 kilometers of previous sightings.

Population Structure

There is no clear understanding of the global population structure of sperm whales (Dufault *et al*. 1999). Recent ocean-wide genetic studies indicate low, but statistically significant, genetic diversity and no clear geographic structure, but strong differentiation between social groups (Lyrholm and Gyllensten 1998; Lyrholm *et al*. 1996, 1999). Chemical analysis also suggests significant differences in diet for animals captured in different regions of the North Atlantic. However, vocal dialects indicate parent-offspring transmission that supports differentiation in populations (Rendell *et al*. 2011). Therefore, population-level differences may be more extensive than are currently understood.

The International Whaling Commission (IWC) currently recognizes four sperm whale stocks: North Atlantic, North Pacific, northern Indian Ocean, and Southern Hemisphere (Reeves and Whitehead 1997; Dufault *et al*. 1999). NMFS recognizes six stocks under the MMPA: three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawaii) (Perry *et al*. 1999; Waring *et al*. 2004). Genetic studies indicate that movements of both sexes through expanses of ocean basins are common, and that males, but not females, often breed in different ocean basins than the ones in which they were born (Whitehead 2003). Sperm whale populations appear to be structured socially, at the level of the clan, rather than geographically (Whitehead 2003, Whitehead *et al*. 2008). Matrilinear groups in the eastern Pacific share nuclear DNA within broader clans, but North Atlantic matrilinear groups do not share this genetic heritage (Whitehead *et al*. 2012).

Feeding

Sperm whales appear to feed regularly throughout the year (NMFS 2006a). It is estimated they consume about 3-3.5% of their body weight daily (Lockyer 1981). They seem to forage mainly on or near the bottom, often ingesting stones, sand, sponges, and other non-food items (Rice 1989a). A large proportion of a sperm whale’s diet consists of low-fat, ammoniacal, or luminescent squids (Clarke 1980b; Martin and Clarke 1986; Clarke 1996). While sperm whales feed primarily on large and medium-sized squids, the list of documented food items is fairly long and diverse. Prey items include other cephalopods, such as octopi, and medium- and large-sized demersal fishes, such as rays, sharks, and many teleosts (Berzin 1972; Clarke 1977, 1980a; Rice 1989a; Angliss and Lodge 2004). The diet of large males in some areas, especially in high northern latitudes, is dominated by fish (Rice 1989a). In some areas of the North Atlantic Ocean, however, males prey heavily on the oil-rich squid *Gonatus fabricii*, a species also frequently eaten by northern bottlenose whales (Clarke 1997).

Diving and Social Behavior

Sperm whales are probably the deepest and longest diving mammalian species, with dives to three kilometers down and durations in excess of two hours (Clarke 1976; Watkins 1985; Watkins *et al*. 1993). However, dives are generally shorter (25-45 minutes) and shallower (400-1,000 meters). Dives are separated by 8-11 minute rests at the surface (Gordon 1987; Papastavrou *et al*. 1989; Jochens *et al*. 2006; Watwood *et al*. 2006). Sperm whales typically travel around three kilometers horizontally and 0.5 kilometers vertically during a foraging dive (Whitehead 2003). Differences in night and day diving patterns are not known for this species, but, like most diving air-breathers for which there are data (e.g., rorquals and fur seals), sperm whales probably make relatively shallow dives at night when prey are closer to the surface.

Davis *et al*. (2007) report that dive-depths (100-500 meters) of sperm whales in the Gulf of California overlapped with depth distributions (200-400 meters) of jumbo squid, based on data from satellite-linked dive recorders placed on both species, particularly during daytime hours. Their research also showed that sperm whales foraged throughout a 24-hour period, and that they rarely dove to the sea floor bottom (>1,000 meters). The most consistent sperm whale dive type is U-shaped, during which the whale makes a rapid descent to the bottom of the dive, forages at various velocities while at depth (likely while chasing prey) and then ascends rapidly to the surface. There is some evidence that male sperm whales, feeding at higher latitudes during summer months, may forage at several depths including <200 meters, and use different strategies depending on position in the water column (Teloni *et al*. 2007).

Stable, long-term associations among females form the core of sperm whale societies (Christal *et al*. 1998). Up to about a dozen females usually live in such groups, accompanied by their female and young male offspring. Young individuals are subject to alloparental care by members of either sex and may be suckled by non-maternal individuals (Gero *et al*. 2009). Group sizes may be smaller overall in the Caribbean Sea (6-12 individuals) versus the Pacific (25-30 individuals) (Jaquet and Gendron 2009). Males start leaving these family groups at about six years of age, after which they live in "bachelor schools," but this may occur more than a decade later (Pinela *et al*. 2009). The cohesion among males within a bachelor school declines with age. During their breeding prime and old age, male sperm whales are essentially solitary (Christal and Whitehead 1997).

Vocalization and Hearing
Sound production and reception by sperm whales are better understood than in most cetaceans. Sperm whales produce broad-band clicks in the frequency range of 100 Hertz to 20 kiloHertz that can be extremely loud for a biological source (200-236 dB re 1μPa), although lower source level energy has been suggested at around 171 dB re 1 μPa (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995; Møhl *et al*. 2003). Most of the energy in sperm whale clicks is concentrated at around 2-4 kiloHertz and 10-16 kiloHertz (Weilgart and Whitehead 1993; Goold and Jones 1995; NMFS 2006b). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Norris and Harvey 1972; Cranford 1992). Long, repeated clicks are associated with feeding and echolocation (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). However, clicks are also used in short patterns (codas) during social behavior and intragroup interactions (Weilgart and Whitehead 1993). They may also aid in intra-specific communication. Another class of sound, "squeals," is produced with frequencies of 100 Hertz to 20 kiloHertz (e.g., Weir *et al*. 2007).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potentials were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5-60 kiloHertz. However, behavioral responses of adult, free-ranging individuals also provide insight into hearing range; sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins *et al*. 1985). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Because they spend large amounts of time at depth and use low frequency sounds, sperm whales are likely to be susceptible to low frequency sounds in the ocean such as those emitted by acoustic sources used in the proposed actions (Croll *et al*. 1999).

Natural Threats
Sperm whales are known to be occasionally predated upon by killer whales (Arnbom *et al*. 1987; Jefferson and Baird 1991; Pitman *et al*. 2001) and large sharks (Best *et al*. 1984) and harassed by pilot whales (Arnbom *et al*. 1987; Rice 1989b; Whitehead 1995; Palacios and Mate 1996; Weller *et al*. 1996). Strandings are also relatively common events, with one to dozens of individuals generally beaching themselves and dying during any single event. Although several hypotheses, such as navigation errors, illness, and anthropogenic stressors, have been proposed (Goold *et al*. 2002; Wright 2005), direct widespread causes of strandings remain unclear. Calcivirus and papillomavirus are known pathogens of this species (Smith and Latham 1978; Lambertsen *et al*. 1987).

Anthropogenic Threats
Sperm whales historically faced severe depletion from commercial whaling operations. From 1800 to 1900, the IWC estimated that nearly 250,000 sperm whales were killed by whalers, with another 700,000 from 1910 to 1982. However, other estimates have included 436,000 individuals killed between 1800 and 1987 (Carretta *et al*. 2005). All of these estimates are likely underestimates due to illegal killings and inaccurate reporting by Soviet whaling fleets between 1947 and 1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC (Yablokov *et al*. 1998), with smaller harvests in the Northern Hemisphere (primarily the North Pacific) that extirpated sperm whales from large areas (Yablokov and Zemsky 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender. Following a moratorium on whaling by the IWC, significant whaling pressures on sperm whales were lessened. Whaling aside, sperm whales are also susceptible to entanglement in commercial fishing gear and vessel strikes (Jensen and Silber 2004). In addition, whale-watching vessels are known to influence sperm whale behavior (Richter *et al*. 2006).

Contaminants have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location, with Northern Hemisphere individuals generally carrying higher burdens (Evans *et al*. 2004). Contaminants include dieldrin, chlordane, DDT, DDE, PCBs, HCB, and hexachlorocyclohexane in a variety of body tissues (Aguilar 1983; Evans *et al*. 2004), as well as several heavy metals (Law *et al*. 1996). However, unlike other marine mammals, females appear to bioaccumulate toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Aguilar 1983; Wise *et al*. 2009). Chromium levels from sperm whale skin samples worldwide have varied from undetectable to 122.6 micrograms/gram tissue, with the mean (8.8 micrograms/gram tissue) resembling levels found in human lung tissue with chromium-induced cancer (Wise *et al*. 2009). Older or larger individuals do not appear to accumulate chromium at higher levels.

Ingestion of marine debris can have fatal consequences even for large whales. In 1989, a stranded sperm whale along the Mediterranean was found to have died from ingesting plastic that blocked its digestive tract. A sperm whale examined in Iceland had a lethal disease thought to have been caused by the complete obstruction of the gut with plastic marine debris (Lambertsen 1990). The stomach contents of two sperm whales that stranded separately in California included extensive amounts of discarded fishing netting (NMFS 2009). A fifth individual from the Pacific was found to contain nylon netting in its stomach when it washed ashore in 2004 (NMFS 2009). In March 2012, a sperm whale stranded dead, apparently dying as a result of plastic ingestion (de Stephanis *et al*. 2013).

Status and Trends

Sperm whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained with the inception of the ESA in 1973. Although population structure of sperm whales is unknown, several studies and estimates of abundance are available. Several estimates from selected regions of sperm whale habitat exist for select time periods, however, at present there is no reliable estimate of total sperm whale abundance in the entire western North Atlantic. Sightings have been almost exclusively in the continental shelf edge and continental slope areas. The best recent abundance estimate for sperm whales is 2,288, which is the sum from the 2011 surveys. Because this sperm whale estimate is not corrected for dive-time, it is likely downwardly biased and an underestimate of actual abundance. The minimum population estimate for the western North Atlantic sperm whale is 1,815 (Waring *et al*. 2015).

Consideration of the status of populations outside of the action area is important under the present analysis to determine how the risk to the affected population(s) bears on the status of the species as a whole. Table 2 below contains historic and current estimates of sperm whales by region. Sperm whale populations probably are undergoing the dynamics of small population sizes, which is a threat in and of itself. In particular, the loss of sperm whales to directed Soviet whaling likely inhibits recovery due to the loss of adult females and their calves, leaving sizeable gaps in demographic and age structuring (Whitehead 2003). Small changes in reproductive parameters, such as the loss of adult females, can significantly alter the population trajectory of sperm whale populations (Chiquet *et al*. 2013).

A total of 190,000 sperm whales were estimated to have been in the entire North Atlantic Ocean, but catch per unit effort data from which this estimate is derived are unreliable according to the IWC (Perry *et al*. 1999). Sperm whales were widely harvested from the northeastern Caribbean Sea (Romero *et al*. 2001) and the Gulf of Mexico where sperm whale fisheries operated during the late 1700s to the early 1900s (Townsend 1935; NMFS 2006b).

Table 2. Summary of past and present sperm whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	~~	~~	~~	900,000	~~	(Würsig et al. 2000)
	~~	1,110,000	672,000-1,512,000	360,000	105,984-614,016*	(Whitehead 2002)
North Atlantic	Basinwide-females	224,800	~~	22,000	~~	(Gosho et al. 1984; Würsig et al. 2000)
	Northeast Atlantic, Faroes, Iceland, and U.S. East coast	~~	~~	13,190	~~	(Whitehead 2002)
	NMFS-North Atlantic stock	>4,685*	~~	4,804	1,226-8,382*	(Waring et al. 2012)
	Iceland	~~	~~	1,234	823-1,645*	(Gunnlaugsson and Sigurjónsson 1990)
	Faroe Islands	~~	~~	308	79-537*	(Gunnlaugsson and Sigurjónsson 1990)
	Norwegian Sea	~~	~~	5,231	2,053-8,409*	(Christensen et al. 1992b)
	Northern Norway to Spitsbergen	15,000	~~	2,548	1,200-3,896*	(Øien 1990)

*Note: Confidence Intervals (CIs) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).

4.2.2 Status of Sea Turtles

With the exception of loggerheads and greens, sea turtles are listed under the ESA at the species level rather than as subspecies or DPSs. Therefore, information on the range-wide status of Kemp's ridley and and leatherback sea turtles is included to provide the status of each species overall. Information on the status of loggerheads and greens will only be presented for the DPS affected by this action. Additional background information on the range-wide status of these species can be found in a number of published documents, including sea turtle status reviews and biological reports (NMFS and USFWS 1995, 2007a, 2007b, 2007c, 2007d, 2015; Hirth 1997; Marine Turtle Expert Working Group [TEWG] 1998, 2000, 2007, 2009; Conant *et al.* 2009; Seminoff *et al.* 2015), and recovery plans for the loggerhead sea turtle (NMFS and USFWS

2008), Kemp's ridley sea turtle (NMFS *et al.* 2011), green sea turtle (NMFS and USFWS 1991), and leatherback sea turtle (NMFS and USFWS 1992, 1998b).

2010 BP Deepwater Horizon Oil Spill
The April 20, 2010, explosion of the Deepwater Horizon oil rig affected sea turtles in the Gulf of Mexico. There is an on-going assessment of the long-term effects of the spill on Gulf of Mexico marine life, including sea turtle populations. Following the spill, juvenile Kemp's ridley, green, and loggerhead sea turtles were found in *Sargassum* algae mats in the convergence zones, where currents meet and oil collected. Sea turtles found in these areas were often coated in oil and/or had ingested oil. Approximately 536 live adult and juvenile sea turtles were recovered from the Gulf and brought into rehabilitation centers; of these, 456 were visibly oiled (these and the following numbers were obtained from http://www.nmfs.noaa.gov/pr/health/oilspill/gulf2010.htm). To date, 469 of the live recovered sea turtles have been successfully returned to the wild, 25 died during rehabilitation, and 42 are still in care but will hopefully be returned to the wild eventually. During the clean-up period, 613 dead sea turtles were recovered in coastal waters or on beaches in Mississippi, Alabama, Louisiana, and the Florida Panhandle. As of February 2011, 478 of these dead turtles had been examined. Many of the examined sea turtles showed indications that they had died as a result of interactions with trawl gear, most likely used in the shrimp fishery, and not as a result of exposure to or ingestion of oil.

During the spring and summer of 2010, nearly 300 sea turtle nests were relocated from the northern Gulf to the east coast of Florida with the goal of preventing hatchlings from entering the oiled waters of the northern Gulf. From these relocated nests, 14,676 sea turtles, including 14,235 loggerheads, 125 Kemp's ridleys, and 316 greens, were ultimately released from Florida beaches.

A thorough assessment of the long-term effects of the spill on sea turtles has not yet been completed. However, the spill resulted in the direct mortality of many sea turtles and may have had sublethal effects or caused environmental damage that will impact other sea turtles into the future. The population level effects of the spill and associated response activity are likely to remain unknown for some period into the future.

4.2.2.1 Status of Loggerhead Sea Turtles – Northwest Atlantic DPS

The loggerhead is the most abundant species of sea turtle in U.S. waters. Loggerhead sea turtles are found in temperate and subtropical waters and occupy a range of habitats including offshore waters, continental shelves, bays, estuaries, and lagoons. They are also exposed to a variety of natural and anthropogenic threats in the terrestrial and marine environment.

Listing History
Loggerhead sea turtles were listed as threatened throughout their global range on July 28, 1978. Since that time, several status reviews have been conducted to review the status of the species and make recommendations regarding its ESA listing status. Based on a 2007 five-year status review of the species, which discussed a variety of threats to loggerheads including climate change, NMFS and USFWS determined that loggerhead sea turtles should not be delisted or reclassified as endangered. However, it was also determined that an analysis and review of the

species should be conducted in the future to determine whether DPSs should be identified for the loggerhead (NMFS and USFWS 2007a). Genetic differences exist between loggerhead sea turtles that nest and forage in the different ocean basins (Bowen 2003; Bowen and Karl 2007). Differences in the maternally inherited mitochondrial DNA also exist between loggerhead nesting groups that occur within the same ocean basin (TEWG 2000; Pearce 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007; TEWG 2009; NMFS and USFWS 2008). Site fidelity of females to one or more nesting beaches in an area is believed to account for these genetic differences (TEWG 2000; Bowen 2003).

In part to evaluate those genetic differences, in 2008, NMFS and USFWS established a Loggerhead Biological Review Team (BRT) to assess the global loggerhead population structure to determine whether DPSs exist and, if so, the status of each DPS. The BRT evaluated genetic data, tagging and telemetry data, demographic information, oceanographic features, and geographic barriers to determine whether population segments exist. The BRT report was completed in August 2009 (Conant *et al.* 2009). In this report, the BRT identified the following nine DPSs as being discrete from other conspecific population segments and significant to the species: (1) North Pacific Ocean, (2) South Pacific Ocean, (3) North Indian Ocean, (4) Southeast Indo-Pacific Ocean, (5) Southwest Indian Ocean, (6) Northwest Atlantic Ocean, (7) Northeast Atlantic Ocean, (8) Mediterranean Sea, and (9) South Atlantic Ocean.

The BRT concluded that although some DPSs are indicating increasing trends at nesting beaches (Southwest Indian Ocean and South Atlantic Ocean), available information about anthropogenic threats to juveniles and adults in neritic and oceanic environments indicate possible unsustainable additional mortalities. According to an analysis using expert opinion in a matrix model framework, the BRT report stated that all loggerhead DPSs have the potential to decline in the foreseeable future. Based on the threat matrix analysis, the potential for future decline was reported as greatest for the North Indian Ocean, Northwest Atlantic Ocean, Northeast Atlantic Ocean, Mediterranean Sea, and South Atlantic Ocean DPSs (Conant *et al.* 2009). The BRT concluded that the North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Southeast Indo-Pacific Ocean, Northwest Atlantic Ocean, Northeast Atlantic Ocean, and Mediterranean Sea DPSs were at risk of extinction. The BRT concluded that although the Southwest Indian Ocean and South Atlantic Ocean DPSs were likely not currently at immediate risk of extinction, the extinction risk was likely to increase in the foreseeable future.

On March 16, 2010, NMFS and USFWS published a proposed rule (75 FR 12598) to divide the worldwide population of loggerhead sea turtles into nine DPSs, as described in the 2009 Status Review. Two of the DPSs were proposed to be listed as threatened and seven of the DPSs, including the Northwest Atlantic Ocean DPS, were proposed to be listed as endangered. NMFS and USFWS accepted comments on the proposed rule through September 13, 2010 (75 FR 30769, June 2, 2010). On March 22, 2011 (76 FR 15932), NMFS and USFWS extended the date by which a final determination on the listing action would be made to no later than September 16, 2011. This action was taken to address the interpretation of the existing data on status and trends and its relevance to the assessment of risk of extinction for the Northwest Atlantic Ocean DPS, as well as the magnitude and immediacy of the fisheries bycatch threat and measures to reduce this threat. New information or analyses to help clarify these issues were requested by April 11, 2011.

On September 22, 2011, NMFS and USFWS issued a final rule (76 FR 58868), determining that the loggerhead sea turtle is composed of nine DPSs (as defined in Conant *et al*. 2009) that constitute species that may be listed as threatened or endangered under the ESA. Five DPSs were listed as endangered (North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea), and four DPSs were listed as threatened (Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean). Note that the Northwest Atlantic Ocean (NWA) DPS and the Southeast Indo-Pacific Ocean DPS were originally proposed as endangered. The NWA DPS was determined to be threatened based on review of nesting data available after the proposed rule was published, information provided in public comments on the proposed rule, and further discussions within the agencies. The two primary factors considered were population abundance and population trend. NMFS and USFWS found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats. This final listing rule became effective on October 24, 2011.

The September 2011 final rule also noted that critical habitat for the two DPSs occurring within the U.S. (NWA DPS and North Pacific DPS) would be designated in a future rulemaking. Information from the public related to the identification of critical habitat, essential physical or biological features for this species, and other relevant impacts of a critical habitat designation was solicited. On July 10, 2014, the USFWS and NMFS published two separate final rules in the Federal Register designating critical habitat for the NWA DPS of loggerhead sea turtles under the ESA (79 FR 39755 for nesting beaches under FWS jurisdiction; 79 FR 39856 for marine areas under NMFS jurisdiction). Effective August 11, 2014, NMFS's final rule for marine areas designated 38 occupied areas within the at-sea range of the DPS. These recently designated marine areas of critical habitat contain one or a combination of: nearshore reproductive habitat, overwintering habitat, breeding habitat, migratory habitat, and *Sargassum* habitat.

Presence of Loggerhead Sea Turtles in the Action Area

The effects of this proposed action are only experienced within the Atlantic Ocean. NMFS has considered the available information on the distribution of the nine DPSs to determine the origin of any loggerhead sea turtles that may occur in the action area. As noted in Conant *et al.* (2009), the range of the four DPSs occurring in the Atlantic Ocean are as follows: NWA DPS – north of the equator, south of 60° N latitude, and west of 40° W longitude; Northeast Atlantic Ocean (NEA) DPS – north of the equator, south of 60° N latitude, east of 40° W longitude, and west of 5° 36' W longitude; South Atlantic DPS – south of the equator, north of 60° S latitude, west of 20° E longitude, and east of 60° W longitude; Mediterranean DPS – the Mediterranean Sea east of 5° 36' W longitude. These boundaries were determined based on oceanographic features, loggerhead sightings, thermal tolerance, fishery bycatch data, and information on loggerhead distribution from satellite telemetry and flipper tagging studies. While adults are highly structured with no overlap, there may be some degree of overlap by juveniles of the NWA, NEA, and Mediterranean DPSs on oceanic foraging grounds (Laurent *et al.* 1993, 1998; Bolten *et al.* 1998; LaCasella *et al.* 2005; Carreras *et al.* 2006, Monzón-Argüello *et al.* 2006; Revelles *et al.* 2007). Previous literature (Bowen *et al.* 2004) has suggested that there is the potential, albeit small, for some juveniles from the Mediterranean DPS to be present in U.S. Atlantic coastal foraging grounds. These conclusions must be interpreted with caution however, as they may be representing a shared common haplotype and lack of representative sampling at Eastern Atlantic rookeries rather than an actual presence of Mediterranean DPS turtles in U.S. Atlantic coastal waters. A re-analysis of the data by the Atlantic Loggerhead Turtle Expert Working Group has found that that it is unlikely that U.S. fishing fleets are interacting with either the NEA or Mediterranean DPS (Peter Dutton, NMFS, Marine Turtle Genetics Program, Program Leader, personal communication, September 10, 2011). Given that the action area is a subset of the area fished by U.S. fleets, it is reasonable to assume that based on this new analysis, no individuals from the NEA or Mediterranean DPS would be present in the action area. Sea turtles of the South Atlantic DPS do not inhabit the action area of this consultation (Conant *et al.* 2009). As such, the remainder of this consultation will only focus on the NWA DPS, listed as threatened.

Distribution and Life History

Ehrhart *et al.* (2003) provided a summary of the literature identifying known nesting habitats and foraging areas for loggerheads within the Atlantic Ocean. Detailed information is also provided in the five-year status review for loggerheads (NMFS and USFWS 2007a), the TEWG (2009) report, and the final revised recovery plan for loggerheads in the Northwest Atlantic Ocean (NMFS and USFWS 2008), which is a second revision to the original recovery plan that was approved in 1984 and subsequently revised in 1991.

In the western Atlantic, waters as far north as the Gulf of Maine and the Canadian Maritimes are used for foraging by juveniles as well as adults (Shoop 1987; Shoop and Kenney 1992; Ehrhart *et al.* 2003; Mitchell *et al.* 2003; NEFSC 2011a). In U.S. Atlantic waters, loggerheads commonly occur throughout the inner continental shelf from Florida to Cape Cod, Massachusetts and in the Gulf of Mexico from Florida to Texas, although their presence varies with the seasons due to changes in water temperature (Shoop and Kenney 1992; Epperly *et al.* 1995a, 1995b; Braun and Epperly 1996; Mitchell *et al.* 2003; Braun-McNeill *et al.* 2008). Loggerheads have been observed in waters with surface temperatures of 7°C to 30°C, but water temperatures ≥11°C are most favorable (Shoop and Kenney 1992; Epperly *et al.* 1995b). The presence of loggerhead sea turtles in U.S. Atlantic waters is also influenced by water depth. Aerial surveys of continental shelf waters north of Cape Hatteras, North Carolina indicated that loggerhead sea turtles were most commonly sighted in waters with bottom depths ranging from 22 to 49 meters deep (Shoop and Kenney 1992). However, more recent survey and satellite tracking data support that they occur in waters from the beach to beyond the continental shelf (Mitchell *et al.* 2003; Braun-McNeill and Epperly 2004; Mansfield 2006; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007; Mansfield *et al.* 2009).

Loggerhead sea turtles occur year round in ocean waters off North Carolina, South Carolina, Georgia, and Florida. In these areas of the South Atlantic Bight, water temperature is influenced by the proximity of the Gulf Stream. As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the Southeast U.S. (e.g., Pamlico and Core Sounds) and also move up the U.S. Atlantic coast (Epperly *et al.* 1995a, 1995b, 1995c; Braun-McNeill and Epperly 2004), occurring in Virginia foraging areas as early as April/May and on the most northern foraging grounds in the Gulf of Maine in June (Shoop and Kenney 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by mid-September but some turtles may remain in Mid-Atlantic and Northeast areas until late fall. By December, loggerheads have migrated from inshore and more northern coastal waters to waters offshore of North Carolina, particularly off of Cape Hatteras, and waters further south where the influence of the Gulf Stream provides temperatures favorable to sea turtles (Shoop and Kenney 1992; Epperly *et al.* 1995b).

Recent studies have established that the loggerhead's life history is more complex than previously believed. Rather than making discrete developmental shifts from oceanic to neritic environments, research is showing that both adults and (presumed) neritic stage juveniles continue to use the oceanic environment and will move back and forth between the two habitats (Witzell 2002; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007; Mansfield *et al.* 2009). One of the studies tracked the movements of adult post-nesting females and found that differences in habitat use were related to body size with larger adults staying in coastal waters and smaller adults traveling to oceanic waters (Hawkes *et al.* 2006). A tracking study of large juveniles found that the habitat preferences of this life stage were also diverse with some remaining in neritic waters and others moving off into oceanic waters (McClellan and Read 2007). However, unlike the Hawkes *et al.* (2006) study, there was no significant difference in the body size of turtles that remained in neritic waters versus oceanic waters (McClellan and Read 2007).

Pelagic and benthic juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988; NMFS and USFWS 2008). Sub-adult and adult loggerheads are primarily coastal dwelling and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats (NMFS and USFWS 2008).

As presented on the following page, Table 3 from the 2008 loggerhead recovery plan (Table 3 in this Opinion) highlights the key life history parameters for loggerheads nesting in the U.S.

Population Dynamics and Status

By far, the majority of Atlantic nesting occurs on beaches of the southeastern U.S. (NMFS and USFWS 2007a). For the past decade or so, the scientific literature has recognized five distinct nesting groups, or subpopulations, of loggerhead sea turtles in the Northwest Atlantic, divided geographically as follows: (1) a northern group of nesting females that nest from North Carolina to northeast Florida at about 29° N latitude; (2) a south Florida group of nesting females that nest from 29° N latitude on the east coast to Sarasota on the west coast; (3) a Florida Panhandle group of nesting females that nest around Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán group of nesting females that nest on beaches of the eastern Yucatán Peninsula, Mexico; and (5) a Dry Tortugas group that nests on beaches of the islands of the Dry Tortugas, near Key West, Florida and on Cal Sal Bank (TEWG 2009). Genetic analyses of mitochondrial DNA, which a sea turtle inherits from its mother, indicate that there are genetic differences between loggerheads that nest at and originate from the beaches used by each of the five identified nesting groups of females (TEWG 2009). However, analyses of microsatellite loci from nuclear DNA, which represents the genetic contribution from both parents, indicates little to no genetic differences between loggerheads originating from nesting beaches of the five Northwest Atlantic nesting groups (Pearce and Bowen 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007). These results suggest that female loggerheads have site fidelity to nesting beaches within a particular area, while males provide an avenue of gene flow between nesting

Table 3: Typical values of life history parameters for loggerheads nesting in the U.S.

Life History Parameter	**Data**
Clutch size	100-126 eggs[1]
Egg incubation duration (varies depending on time of year and latitude)	42-75 days[2,3]
Pivotal temperature (incubation temperature that produces an equal number of males and females)	29.0°C[5]
Nest productivity (emerged hatchlings/total eggs) x 100 (varies depending on site specific factors)	45-70%[2,6]
Clutch frequency (number of nests/female/season)	3-5.5 nests[7]
Internesting interval (number of days between successive nests within a season)	12-15 days[8]
Juvenile (<87 cm CCL) sex ratio	65-70% female[4]
Remigration interval (number of years between successive nesting migrations)	2.5-3.7 years[9]
Nesting season	late April-early September
Hatching season	late June-early November
Age at sexual maturity	32-35 years[10]
Life span	>57 years[11]

1 Dodd 1988.
2 Dodd and Mackinnon (1999, 2000, 2001, 2002, 2003, 2004).
3 Blair Witherington, FFWCC, personal communication, 2006 (information based on nests monitored throughout Florida beaches in 2005, n=865).
4 National Marine Fisheries Service (2001); Allen Foley, FFWCC, personal communication, 2005.
5 Mrosovsky (1988).
6 Blair Witherington, FFWCC, personal communication, 2006 (information based on nests monitored throughout Florida beaches in 2005, n=1,680).
7 Murphy and Hopkins (1984); Frazer and Richardson (1985); Ehrhart, unpublished data; Hawkes *et al*. 2005; Scott 2006; Tony Tucker, Mote Marine Laboratory, personal communication, 2008.
8 Caldwell (1962), Dodd (1988).
9 Richardson *et al*. (1978); Bjorndal *et al*. (1983); Ehrhart, unpublished data.
10 Melissa Snover, NMFS, personal communication, 2005; see Table A1-6.
11 Dahlen *et al*. (2000).

groups by mating with females that originate from different nesting groups (Bowen 2003; Bowen *et al*. 2005). The extent of such gene flow, however, is unclear (Shamblin 2007).

The lack of genetic structure makes it difficult to designate specific boundaries for the nesting subpopulations based on genetic differences alone. Therefore, the Loggerhead Recovery Team recently used a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to reassess the designation of these subpopulations to identify recovery units in the 2008 recovery plan.

In the 2008 recovery plan, the Loggerhead Recovery Team designated five recovery units for the Northwest Atlantic population of loggerhead sea turtles based on the aforementioned nesting groups and inclusive of a few other nesting areas not mentioned above. The first four of these recovery units represent nesting assemblages located in the Southeast U.S. The fifth recovery unit is composed of all other nesting assemblages of loggerheads within the Greater Caribbean, outside the U.S., but which occur within U.S. waters during some portion of their lives. The five recovery units representing nesting assemblages are: (1) the Northern Recovery Unit (NRU: Florida/Georgia border through southern Virginia), (2) the Peninsular Florida Recovery Unit (PFRU: Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (DTRU: islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (NGMRU: Franklin County, Florida through Texas), and (5) the Greater Caribbean Recovery Unit (GCRU: Mexico through French Guiana, Bahamas, Lesser Antilles, and Greater Antilles).

The Loggerhead Recovery Team evaluated the status and trends of the Northwest Atlantic loggerhead population for each of the five recovery units, using nesting data available as of October 2008 (NMFS and USFWS 2008). The level and consistency of nesting coverage varies among recovery units, with coverage in Florida generally being the most consistent and thorough over time. Since 1989, nest count surveys in Florida have occurred in the form of statewide surveys (a near complete census of entire Florida nesting) and index beach surveys (Witherington *et al.* 2009). Index beaches were established to standardize data collection methods and maintain a constant level of effort on key nesting beaches over time.

NMFS and USFWS (2008), Witherington *et al.* (2009), and TEWG (2009) analyzed the status of the nesting assemblages within the NWA DPS using standardized data collected over periods ranging from 10-23 years. These analyses used different analytical approaches, but found the same finding that there had been a significant, overall nesting decline within the NWA DPS. However, with the addition of nesting data from 2008 to 2015, the trend line changes, showing a strong positive trend since 2007 (http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). The nesting data presented in the Recovery Plan (through 2008) is described below, with updated trend information through 2010 for two recovery units.

From the beginning of standardized index surveys in 1989 until 1998, the PFRU, the largest nesting assemblage in the Northwest Atlantic by an order of magnitude, had a significant increase in the number of nests. However, from 1998 through 2008, there was a 41% decrease in annual nest counts from index beaches, which represent an average of 70% of the statewide nesting activity (NMFS and USFWS 2008). From 1989-2008, the PFRU had an overall declining nesting trend of 26% (95% CI: -42% to -5%; NMFS and USFWS 2008). With the addition of nesting data through 2010, the nesting trend for the PFRU does not show a nesting decline statistically different from zero (76 FR 58868, September 22, 2011). The NRU, the second largest nesting assemblage of loggerheads in the U.S., has been declining at a rate of 1.3% annually since 1983 (NMFS and USFWS 2008). The NRU dataset included 11 beaches with an uninterrupted time series of coverage of at least 20 years; these beaches represent approximately 27% of NRU nesting (in 2008). Through 2008, there was strong statistical data to suggest the NRU has experienced a long-term decline, but with the inclusion of nesting data through 2010, nesting for the NRU is showing possible signs of stabilizing (76 FR 58868, September 22, 2011). Evaluation of long-term nesting trends for the NGMRU is difficult because of changed and expanded beach coverage. However, the NGMRU has shown a significant declining trend of 4.7% annually since index nesting beach surveys were initiated in 1997 (NMFS and USFWS

2008). No statistical trends in nesting abundance can be determined for the DTRU because of the lack of long-term data. Similarly, statistically valid analyses of long-term nesting trends for the entire GCRU are not available because there are few long-term standardized nesting surveys representative of the region. Additionally, changing survey effort at monitored beaches and scattered and low-level nesting by loggerheads at many locations currently precludes comprehensive analyses (NMFS and USFWS 2008).

Sea turtle census nesting surveys are important in that they provide information on the relative abundance of nesting each year, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The 2008 recovery plan compiled information on mean number of loggerhead nests and the approximated counts of nesting females per year for four of the five identified recovery units (i.e., nesting groups). They are: (1) for the NRU, a mean of 5,215 loggerhead nests per year (from 1989-2008) with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year (from 1989-2007) with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year (from 1995-2004, excluding 2002) with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year (from 1995-2007) with approximately 221 females nesting per year. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit. Note that the above values for average nesting females per year were based upon 4.1 nests per female per Murphy and Hopkins (1984).

Genetic studies of juvenile and a few adult loggerhead sea turtles collected from Northwest Atlantic foraging areas (beach strandings, a power plant in Florida, and North Carolina fisheries) show that the loggerheads that occupy U.S. East Coast waters originate from these Northwest Atlantic nesting groups; primarily from the nearby nesting beaches of southern Florida, as well as the northern Florida to North Carolina beaches, and finally from the beaches of the Yucatán Peninsula, Mexico (Rankin-Baransky *et al.* 2001; Witzell *et al.* 2002; Bass *et al.* 2004; Bowen *et al.* 2004). The contribution of these three nesting assemblages varies somewhat among the foraging habitats and age classes surveyed along the east coast. The distribution is not random and bears a significant relationship to the proximity and size of adjacent nesting colonies (Bowen *et al.* 2004). Bass *et al.* (2004) attribute the variety in the proportions of sea turtles from loggerhead nesting assemblages documented in different east coast foraging habitats to a complex interplay of currents and the relative size and proximity of nesting beaches.

Unlike nesting surveys, in-water studies of sea turtles typically sample both sexes and multiple age classes. In-water studies have been conducted in some areas of the Northwest Atlantic and provide data by which to assess the relative abundance of loggerhead sea turtles and changes in abundance over time (Maier *et al.* 2004; Morreale *et al.* 2005; Mansfield 2006; Ehrhart *et al.* 2007; Epperly *et al.* 2007). The TEWG (2009) used raw data from six in-water study sites to conduct trend analyses. They identified an increasing trend in the abundance of loggerheads from three of the four sites located in the Southeast U.S., one site showed no discernible trend, and the two sites located in the northeast U.S. showed a decreasing trend in abundance of loggerheads. The 2008 loggerhead recovery plan also includes a full discussion of in-water population studies for which trend data have been reported, and a brief summary will be provided here.

Maier *et al.* (2004) used fishery-independent trawl data to establish a regional index of loggerhead abundance for the southeast coast of the U.S. (Winyah Bay, South Carolina to St. Augustine, Florida) during the period 2000-2003. A comparison of loggerhead catch data from this study with historical values suggested that in-water populations of loggerhead sea turtles along the southeast U.S. coast appear to be larger, possibly an order of magnitude higher than they were 25 years ago, but the authors caution a direct comparison between the two studies given differences in sampling methodology (Maier *et al.* 2004). A comparison of catch rates for sea turtles in pound net gear fished in the Pamlico-Albemarle Estuarine Complex of North Carolina between the years 1995-1997 and 2001-2003 found a significant increase in catch rates for loggerhead sea turtles for the latter period (Epperly *et al.* 2007). A long-term, on-going study of loggerhead abundance in the Indian River Lagoon System of Florida found a significant increase in the relative abundance of loggerheads over the last four years of the study (Ehrhart *et al.* 2007). However, there was no discernible trend in loggerhead abundance during the 24-year time period of the study (1982-2006) (Ehrhart *et al.* 2007). At St. Lucie Power Plant, data collected from 1977-2004 show an increasing trend of loggerheads at the power plant intake structures (FPL and Quantum Resources 2005).

In contrast to these studies, Morreale *et al.* (2005) observed a decline in the percentage and relative numbers of loggerhead sea turtles incidentally captured in pound net gear fished around Long Island, New York during the period 2002-2004 in comparison to the period 1987-1992, with only two loggerheads (of a total 54 turtles) observed captured in pound net gear during the period 2002-2004. This is in contrast to the previous decade's study where numbers of individual loggerheads ranged from 11 to 28 per year (Morreale *et al.* 2005). No additional loggerheads were reported captured in pound net gear in New York through 2007, although two were found cold-stunned on Long Island bay beaches in the fall of 2007 (Memo to the File, L. Lankshear, December 2007). Potential explanations for this decline include major shifts in loggerhead foraging areas and/or increased mortality in pelagic or early benthic stage/age classes (Morreale *et al.* 2005). Using aerial surveys, Mansfield (2006) also found a decline in the densities of loggerhead sea turtles in Chesapeake Bay over the period 2001-2004 compared to aerial survey data collected in the 1980s. Significantly fewer loggerheads ($p<0.05$) were observed in both the spring (May-June) and the summer (July-August) of 2001-2004 compared to those observed during aerial surveys in the 1980s (Mansfield 2006). A comparison of median densities from the 1980s to the 2000s suggested that there had been a 63.2% reduction in densities during the spring residency period and a 74.9% reduction in densities during the summer residency period (Mansfield 2006). The decline in observed loggerhead populations in Chesapeake Bay may be related to a significant decline in prey, namely horseshoe crabs and blue crabs, with loggerheads redistributing outside of Bay waters (NMFS and USFWS 2008).

As with other turtle species, population estimates for loggerhead sea turtles are difficult to determine, largely given their life history characteristics. However, a recent loggerhead assessment using a demographic matrix model estimated that the loggerhead adult female population in the western North Atlantic ranges from 16,847 to 89,649, with a median size of

30,050 (SEFSC 2009). The model results for population trajectory suggest that the population is most likely declining, but this result was very sensitive to the choice of the position of the parameters within their range and hypothesized distributions. The pelagic stage survival parameter had the largest effect on the model results. As a result of the large uncertainty in our knowledge of loggerhead life history, at this point predicting the future populations or population trajectories of loggerhead sea turtles with precision is very uncertain. It should also be noted that additional analyses are underway which will incorporate any newly available information.

As part of the Atlantic Marine Assessment Program for Protected Species (AMAPPS), line transect aerial abundance surveys and turtle telemetry studies were conducted along the U.S. Atlantic coast in the summer of 2010. AMAPPS is a multi-agency initiative to assess marine mammal, sea turtle, and seabird abundance and distribution in the Atlantic. Aerial surveys were conducted from Cape Canaveral, Florida to the Gulf of St. Lawrence, Canada. Satellite tags on juvenile loggerheads were deployed in two locations – off the coasts of northern Florida to South Carolina (n=30) and off the New Jersey and Delaware coasts (n=14). As presented in NEFSC (2011a), the 2010 survey found a preliminary total surface abundance estimate within the entire study area of about 60,000 loggerheads (CV=0.13) or 85,000 if a portion of unidentified hard-shelled sea turtles were included (CV=0.10). Surfacing times were generated from the satellite tag data collected during the aerial survey period, resulting in a 7% (5%-11% inter-quartile range) median surface time in the South Atlantic area and a 67% (57%-77% inter-quartile range) median surface time to the north. The calculated preliminary regional abundance estimate is about 588,000 loggerheads along the U.S. Atlantic coast, with an inter-quartile range of 382,000-817,000 (NEFSC 2011a). The estimate increases to approximately 801,000 (inter-quartile range of 521,000-1,111,000) when based on known loggerheads and a portion of unidentified turtle sightings. The density of loggerheads was generally lower in the north than the south; based on number of turtle groups detected, 64% were seen south of Cape Hatteras, North Carolina, 30% in the southern Mid-Atlantic Bight, and 6% in the northern Mid-Atlantic Bight. Although they have been seen farther north in previous studies (e.g., Shoop and Kenney 1992), no loggerheads were observed during the aerial surveys conducted in the summer of 2010 in the more northern zone encompassing Georges Bank, Cape Cod Bay, and the Gulf of Maine. These estimates of loggerhead abundance over the U.S. Atlantic continental shelf are considered very preliminary. A more thorough analysis will be completed pending the results of further studies related to improving estimates of regional and seasonal variation in loggerhead surface time (by increasing the sample size and geographical area of tagging) and other information needed to improve the biases inherent in aerial surveys of sea turtles (e.g., research on depth of detection and species misidentification rate). This survey effort represents the most comprehensive assessment of sea turtle abundance and distribution in many years. Additional aerial surveys and research to improve the abundance estimates are anticipated through 2014, depending on available funds.

Threats

The diversity of a loggerhead sea turtle's life history leaves them susceptible to many natural and human impacts, including impacts while they are on land, in the neritic environment, and in the oceanic environment. The five-year status review and 2008 recovery plan provide a summary of natural as well as anthropogenic threats to loggerhead sea turtles (NMFS and USFWS 2007a, 2008). Amongst those of natural origin, hurricanes are known to be destructive to sea turtle nests. Sand accretion, rainfall, and wave action that result from these storms can appreciably reduce hatchling success. Other sources of natural mortality include cold-stunning, biotoxin exposure, and native species predation.

Anthropogenic factors that impact hatchlings and adult females on land, or the success of nesting and hatching include: beach erosion, beach armoring, and nourishment; artificial lighting; beach cleaning; beach pollution; increased human presence; recreational beach equipment; vehicular and pedestrian traffic; coastal development/construction; exotic dune and beach vegetation; removal of native vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs, and an increased presence of native species (e.g., raccoons, armadillos, and opossums), which raid nests and feed on turtle eggs (NMFS and USFWS 2007a, 2008). Although sea turtle nesting beaches are protected along large expanses of the Northwest Atlantic coast (in areas like Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density East Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerheads are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation; marine pollution; pile driving and underwater explosions; hopper dredging; offshore artificial lighting; power plant entrainment and/or impingement; entanglement in and ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching; and fishery interactions (including both commercial and recreational fisheries).

A 1990 National Research Council (NRC) report concluded that for juveniles, subadults, and breeding adults in coastal waters, the most important source of human caused mortality in U.S. Atlantic waters was fishery interactions. The sizes and reproductive values of sea turtles taken by fisheries vary significantly, depending on the location and season of the fishery, and size-selectivity resulting from gear characteristics. Therefore, it is possible for fisheries that interact with fewer, more reproductively valuable turtles to have a greater detrimental effect on the population than one that takes greater numbers of less reproductively valuable turtles (Wallace *et al.* 2008). The Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant *et al.* 2009). Attaining a more thorough understanding of the characteristics, as well as the quantity of sea turtle bycatch across all fisheries is of great importance.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp’s ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

Of the many fisheries known to adversely affect loggerheads, the U.S. South Atlantic and Gulf of Mexico shrimp fisheries were considered to pose the greatest threat of mortality to neritic juvenile and adult age classes of loggerheads (NRC 1990, Finkbeiner *et al.* 2011). Significant changes to the U.S. South Atlantic and Gulf of Mexico shrimp fisheries have occurred since 1990, and the effects of these shrimp fisheries on ESA-listed species, including loggerhead sea turtles, have been assessed several times through section 7 consultation. There is also a lengthy regulatory history with regard to the use of Turtle Excluder Devices (TEDs) in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries (Epperly and Teas 2002; NMFS 2002; Lewison *et al.* 2003). A section 7 consultation on the U.S. South Atlantic and Gulf of Mexico shrimp fisheries completed in 2002 estimated the total annual level of loggerhead interactions to be 163,160 (the total number of turtles that enter a shrimp trawl, which may then escape through the TED or fail to escape and be captured) with 3,948 of those being lethal (NMFS 2002).

In addition to improvements in TED designs and TED enforcement, interactions between loggerheads and the shrimp fishery have also been declining because of reductions in fishing effort unrelated to fisheries management actions. The 2002 Opinion take estimates were based in part on fishery effort levels. In recent years, low shrimp prices, rising fuel costs, competition with imported products, and the impacts of recent hurricanes in the Gulf of Mexico have all impacted the shrimp fleets; in some cases reducing fishing effort by as much as 50% for offshore waters of the Gulf of Mexico (GMFMC 2007). As a result, loggerhead interactions and mortalities in the Gulf of Mexico have been substantially less than were projected in the 2002 Opinion. In 2008, the NMFS Southeast Fisheries Science Center (SEFSC) estimated annual number of interactions between loggerheads and shrimp trawls in the Gulf of Mexico shrimp fishery to be 23,336, with 647 (2.8%) of those interactions resulting in mortality (Memo from Dr. B. Ponwith, Southeast Fisheries Science Center to Dr. R. Crabtree, Southeast Region, PRD, December 2008). However, the most recent section 7 consultation on the shrimp fishery, completed in May 2012, was unable to estimate the total annual level of loggerhead interactions at present. Instead, it qualitatively estimated that the shrimp fishery, as currently operating, would result in at least thousands and possibly tens of thousands of interactions annually, of which at least hundreds and possibly thousands are expected to be lethal (NMFS 2012a).

Loggerhead sea turtles are also known to interact with non-shrimp trawl, gillnet, longline, dredge, pound net, pot/trap, and hook and line fisheries. The NRC (1990) report stated that other U.S. Atlantic fisheries collectively accounted for 500 to 5,000 loggerhead deaths each year, but recognized that there was considerable uncertainty in the estimate. The reduction of sea turtle captures in fishing operations is identified in recovery plans and five-year status reviews as a priority for the recovery of all sea turtle species. In the threats analysis of the loggerhead recovery plan, trawl bycatch is identified as the greatest source of mortality. Loggerhead bycatch in U.S. Mid-Atlantic bottom otter trawl gear has been previously estimated for the periods of 1996-2004 (Murray 2008) and 2005-2008 (Warden 2011), with the most recent bycatch analysis estimating the number of loggerhead sea turtle interactions with U.S. Mid-Atlantic bottom trawl gear from 2009-2013 (Murray 2015a). From 2009-2013, a total of 1,156 loggerheads (95% CI: 908-1,488) were estimated to have interacted with bottom trawl gear in the U.S. Mid-Atlantic, of which 479 resulted in mortality. The total number of estimated interactions was equivalent to 166 adults, of which 68 resulted in mortality (Murray 2015a). That equates to an annual average of 231 loggerhead interactions (95% CI: 182-298) for the period of 2009-2013. The trawl fishery targeting Atlantic croaker in the southern Mid-Atlantic had the highest turtle interactions among fisheries investigated, which may be due to larger mesh sizes in the mouth of the trawl and high headline height of the gear. Murray (2015a) found that retained catch, depth, latitude, and sea surface temperature (SST) were associated with the interaction rate, with the rates being highest south of 37°N latitude in warm, shallow (<50 meters deep) waters. This estimate is a decrease from the average annual loggerhead bycatch in U.S. Mid-Atlantic bottom otter trawls during the 1996-2004 and 2005-2008 time periods, which were estimated to be 616 (95% CI: 367-890) and 352 turtles (95% CI: 276-439), respectively (Murray 2008; Warden 2011; Murray 2015a).

There have been several published estimates of the number of loggerheads interacting annually with the dredge fishery for Atlantic sea scallops, ranging from a low of zero in 2005 (Murray 2007) to a high of 749 in 2003 (Murray 2004). Murray (2011) re-evaluated loggerhead sea turtle interactions in scallop dredge gear from 2001-2008. In that paper, the average number of annual observable interactions of hard-shelled sea turtles in the Mid-Atlantic scallop dredge fishery prior to the implementation of chain mats (January 1, 2001 through September 25, 2006) was estimated to be 288 turtles (95% CI: 209-363) [equivalent to 49 adults], 218 of which were loggerheads [equivalent to 37 adults]. After the implementation of chain mats, the average annual number of observable interactions was estimated to be 20 hard-shelled sea turtles (95% CI: 3-42), 19 of which were loggerheads. If the rate of observable interactions from dredges without chain mats had been applied to trips with chain mats, the estimated number of observable and inferred interactions of hard-shelled sea turtles after chain mats were implemented would have been 125 turtles per year (95% CI: 88-163) [equivalent to 22 adults], 95 of which were loggerheads [equivalent to 16 adults]. Interaction rates of hard-shelled turtles were correlated with SST, depth, and use of a chain mat. Results from that analysis suggested that chain mats and fishing effort reductions contributed to the decline in estimated loggerhead sea turtle interactions with scallop dredge gear after 2006 (Murray 2011). A more recent analysis has indicated that the average annual observable sea turtle interactions in the Mid-Atlantic scallop dredge fishery plus unobserved, quantifiable interactions was 22 loggerheads per year (95% CI: 4-67), 9-19 of which were lethal (Murray 2015b). The 22 interactions equate to two adult equivalents per year and 1-2 adult equivalent mortalities. Thus, estimated interactions in the scallop dredge fishery have decreased relative to 2001-2008, although the utility of observers as a monitoring tool for turtle interactions in the fishery seems to be decreasing (Murray 2015b).

An estimate of the number of loggerheads interacting annually with U.S. Mid-Atlantic gillnet fisheries has also recently been published (Murray 2013). From 2007-2011, an annual average of 95 hard-shelled sea turtles (95% CI: 60-138) and 89 loggerheads (equivalent to nine adults) were estimated to have interacted with U.S. Mid-Atlantic gillnet gear. An estimated 52 annual loggerhead interactions (equivalent to five adults) were considered to result in mortality. Gillnet trips landing monkfish had the highest estimated number of loggerhead and hard-shelled sea turtle interactions during 2007-2011. Estimated rates and interactions have decreased relative to those from 1996-2006. Bycatch rates were correlated with latitude, SST, and mesh size. High interaction rates are estimated in the southern Mid-Atlantic, in warm surface temperature water, and in large-mesh gillnets; findings which are consistent with prior loggerhead bycatch analyses (Murray 2013).

The U.S. tuna and swordfish longline fisheries that are managed under the Highly Migratory Species (HMS) Fishery Management Plan (FMP) are estimated to capture 1,905 loggerheads (no more than 339 mortalities) for each three-year period starting in 2007 (NMFS 2004a). NMFS has mandated gear changes for the HMS fishery to reduce sea turtle bycatch and the likelihood of death from those incidental takes that would still occur (Garrison and Stokes 2014). In 2013, there were 51 observed interactions between loggerhead sea turtles and longline gear used in the HMS fishery (Garrison and Stokes 2014). All of the loggerheads were released alive, with 33 out of 51 (65%) released with all gear removed. A total of 377.1 (95% CI: 278.8-510.2) loggerhead sea turtles were estimated to have interacted with the longline fisheries managed under the HMS FMP in 2013 based on the observed bycatch events (Garrison and Stokes 2014). Including the 2013 estimate, loggerhead interactions since 2000 have been well below the historical highs that occurred in the mid-1990s (Garrison and Stokes 2014). Generally, the period from 2009-2013 has lower overall estimates of loggerhead takes relative to previous cycles despite a generally increasing trend in fishing effort over time (Garrison and Stokes 2014). This fishery represents just one of several longline fisheries operating in the Atlantic Ocean. Lewison *et al*. (2004) estimated that 150,000-200,000 loggerheads were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries as well as others).

Documented interactions also occur in other fishery gear types and by non-fishery mortality sources (e.g., hopper dredges, power plants, vessel collisions), although quantitative/qualitative estimates are only available for activities on which NMFS has consulted.

The most recent Recovery Plan for loggerhead sea turtles as well as the 2009 Status Review Report identifies global climate change as a threat to loggerhead sea turtles. However, trying to assess the likely effects of climate change on loggerhead sea turtles is extremely difficult given the uncertainty in all climate change models and the difficulty in determining the likely rate of temperature increases and the scope and scale of any accompanying habitat effects. Additionally, no significant climate change-related impacts to loggerhead sea turtle populations have been observed to date. Over the long-term, climate change related impacts are expected to influence biological trajectories on a century scale (Parmesan and Yohe 2003). As noted in the 2009 Status Review (Conant *et al*. 2009), impacts from global climate change induced by human activities are likely to become more apparent in future years (IPCC 2007a). Climate change related increasing temperatures, sea level rise, changes in ocean productivity, and increased frequency of storm events may affect loggerhead sea turtles.

Increasing temperatures are expected to result in rising sea levels (Titus and Narayanan 1995 in Conant *et al*. 2009), which could result in increased erosion rates along nesting beaches. Sea level rise could result in the inundation of nesting sites and decrease available nesting habitat (Daniels *et al*. 1993; Fish *et al*. 2005; Baker *et al*. 2006). The BRT noted that the loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis *et al*. 2006; Baker *et al*. 2006; both in Conant *et al*. 2009). Along developed coastlines, and especially in areas where erosion control structures have been constructed to limit shoreline movement, rising sea levels may cause severe effects on nesting females and their eggs as nesting females may deposit eggs seaward of the erosion control structures potentially subjecting them to repeated tidal inundation. However, if global temperatures increase and there is a range shift northwards, beaches not currently used for nesting may become available for loggerhead sea turtles, which may offset some loss of accessibility to beaches in southern portions of the range.

Climate change also has the potential to result in changes at nesting beaches that may affect loggerhead sex ratios. Loggerhead sea turtles exhibit temperature-dependent sex determination. Rapidly increasing global temperatures may result in warmer incubation temperatures and highly female-biased sex ratios (e.g., Glen and Mrosovsky 2004; Hawkes *et al*. 2009); however, to the extent that nesting can occur at beaches further north where sand temperatures are not as warm, these effects may be partially offset. The BRT specifically identified climate change as a threat to loggerhead sea turtles in the neritic/oceanic zone where climate change may result in future trophic changes, thus impacting loggerhead prey abundance and/or distribution. In the threats matrix analysis, climate change was considered for oceanic juveniles and adults as well as for eggs/hatchlings. The report states that for oceanic juveniles and adults, "although the effect of trophic level change from…climate change…is unknown it is believed to be very low." For eggs/hatchlings, the report states that total mortality from anthropogenic causes, including sea level rise resulting from climate change, is believed to be low relative to the entire life stage. However, only limited data are available on past trends related to climate effects on loggerhead sea turtles; current scientific methods are not able to reliably predict the future magnitude of climate change, associated impacts, whether and to what extent some impacts will offset others, or the adaptive capacity of this species.

While there is a reasonable degree of certainty that certain climate change related effects will be experienced globally (e.g., rising temperatures and changes in precipitation patterns), due to a lack of scientific data, the specific effects to sea turtles resulting from climate change are not predictable or quantifiable at this time (Hawkes *et al*. 2009). Based on the BRT report, it is unlikely that impacts from climate change will have a significant effect on the status of loggerheads over the scope of the action assessed in this Opinion. This is because significant changes to biological trajectories resulting from climate change are expected to occur gradually over time (on a century scale), rather than immediately (Parmesan and Yohe 2003). However, significant impacts from climate change in the future beyond 2016 are to be expected, but the severity of and rate at which these impacts will occur is currently unknown. It is likely that once climate change impacts get to a certain level, there will be feedback loops that may cause indications of climate change (e.g., increases in greenhouse gas concentrations, rising global temperatures, and sea level rise) to get much worse much more quickly (Torn and Harte 2006).

In terms of "climate forcing" (which is different from what we are defining as "climate change," in that it also factors in the effects of cyclical climate patterns such as the North Atlantic and Pacific Decadal Oscillations in addition to ongoing effects from anthropogenically-induced changes in climate under Intergovernmental Panel on Climate Change [IPCC] projections), Van Houtan and Halley (2011) recently developed climate-based models to investigate loggerhead nesting in the Northwest Atlantic and North Pacific. These models, which considered juvenile recruitment and breeding remigration, found that climate conditions/oceanographic influences explain loggerhead nesting variability, with climate models alone explaining an average of 60% (range 18%-88%) of the observed nesting changes over the past several decades. Hindcasts indicate that climatic conditions may have been a factor in past nesting declines in both the Atlantic and Pacific. However, in terms of future nesting projections, modeled climate data show a future positive trend for Atlantic nesting in Florida, with substantial increases through 2040 as a result of the Atlantic Multidecadal Oscillation signal (Van Houton and Halley 2011). Thus, independent of any dramatic losses of sea turtle nesting habitat in the Northwest Atlantic due to climate change, NWA DPS loggerheads are expected to increase their nesting output over the next few decades. Van Houton and Halley (2011) did not project nesting trends in the Northwest Atlantic beyond 2040 as forecasting beyond that point was not deemed possible given their methods. Much like our analyses of climate change, climate forcing analyses can only predict so far into the future.

Summary of Status for the Northwest Atlantic DPS of Loggerhead Sea Turtles

Loggerheads continue to be affected by many factors occurring on nesting beaches and in the water. These include poaching, habitat loss, and nesting predation that affects eggs, hatchlings, and nesting females on land, as well as fishery interactions, vessel interactions, marine pollution, and non-fishery (e.g., dredging) operations affecting all sexes and age classes in the water (NRC 1990; NMFS and USFWS 2007a, 2008). As a result, loggerheads still face many of the original threats that were the cause of their listing under the ESA.

As mentioned previously, a final revised recovery plan for loggerhead sea turtles in the Northwest Atlantic was published by NMFS and USFWS in December 2008. The revised recovery plan is significant in that it identifies five unique recovery units, which comprise the population of loggerheads in the Northwest Atlantic, and describes specific recovery criteria for each recovery unit. The recovery plan noted a decline in annual nest counts for three of the five recovery units for loggerheads in the Northwest Atlantic, including the PFRU, which is the largest (in terms of number of nests laid) in the Atlantic Ocean. The nesting trends for the other two recovery units could not be determined due to an absence of long term data.

NMFS convened a new Loggerhead Turtle Expert Working Group (TEWG) to review all available information on Atlantic loggerheads in order to evaluate the status of this species in the Atlantic. A final report from the Loggerhead TEWG was published in July 2009. In this report, the TEWG indicated that it could not determine whether the decreasing annual numbers of nests among the Northwest Atlantic loggerhead subpopulations were due to stochastic processes resulting in fewer nests, a decreasing average reproductive output of adult females, decreasing numbers of adult females, or a combination of these factors. Many factors are responsible for past or present loggerhead mortality that could impact current nest numbers; however, no single mortality factor stands out as a likely primary factor. It is likely that several factors compound to create the current decline, including incidental capture (in fisheries, power plant intakes, and dredging operations), lower adult female survival rates, increases in the proportion of first-time nesters, continued directed harvest, and increases in mortality due to disease. Regardless, the TEWG stated that “it is clear that the current levels of hatchling output will result in depressed recruitment to subsequent life stages over the coming decades” (TEWG 2009). However, the report does not provide information on the rate or amount of expected decrease in recruitment but goes on to state that the ability to assess the current status of loggerhead stocks is limited due to a lack of fundamental life history information and specific census and mortality data.

While several documents reported the decline in nesting numbers in the NWA DPS (NMFS and USFWS 2008, TEWG 2009), when nest counts through 2010 are analyzed, the nesting trends from 1989-2010 are not significantly different than zero for all recovery units within the NWA DPS for which there are enough data to analyze (76 FR 58868, September 22, 2011). The SEFSC (2009) estimated the number of adult females in the NWA DPS at 30,000, and if a 1:1 adult sex ratio is assumed, the result is 60,000 adults in this DPS. Based on the reviews of nesting data, as well as information on population abundance and trends, NMFS and USFWS determined in the September 2011 listing rule that the NWA DPS should be listed as threatened. They found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats.

4.2.2.2 Status of Kemp's Ridley Sea Turtles

Distribution and Life History
The Kemp's ridley is one of the least abundant of the world's sea turtle species. In contrast to loggerhead, leatherback, and green sea turtles, which are found in multiple oceans of the world, Kemp's ridleys typically occur only in the Gulf of Mexico and the northwestern Atlantic Ocean (NMFS *et al.* 2011).

Kemp's ridleys mature at 10-17 years (Caillouet *et al.* 1995; Schmid and Witzell 1997; Snover *et al.* 2007; NMFS and USFWS 2015). Nesting occurs from April through July each year with hatchlings emerging after 45-58 days (NMFS *et al.* 2011). Females lay an average of 2.5 clutches within a season (TEWG 1998, 2000) and the mean remigration interval for adult females is two years (Márquez *et al.* 1982; TEWG 1998, 2000).

Once they leave the nesting beach, hatchlings presumably enter the Gulf of Mexico where they feed on available S*argassum* and associated infauna or other epipelagic species (NMFS *et al.* 2011). The presence of juvenile turtles along both the U.S. Atlantic and Gulf of Mexico coasts, where they are recruited to the coastal benthic environment, indicates that post-hatchlings are distributed in both the Gulf of Mexico and Atlantic Ocean (TEWG 2000).

The location and size classes of dead turtles recovered by the Sea Turtle Stranding and Salvage Network (STSSN) suggests that benthic immature developmental areas occur along the U.S. coast and that these areas may change given resource quality and quantity (TEWG 2000). Developmental habitats are defined by several characteristics, including coastal areas sheltered from high winds and waves such as embayments and estuaries, and nearshore temperate waters shallower than 50 meters (NMFS and USFWS 2015). The suitability of these habitats depends on resource availability, with optimal environments providing rich sources of crabs and other invertebrates. Kemp's ridleys consume a variety of crab species, including *Callinectes*, *Ovalipes*, *Libinia*, and *Cancer* species. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997). A wide variety of substrates have been documented to provide good foraging habitat, including seagrass beds, oyster reefs, sandy and mud bottoms, and rock outcroppings (NMFS and USFWS 2015).

Foraging areas documented along the U.S. Atlantic coast include Charleston Harbor, Pamlico Sound (Epperly *et al.* 1995c), Chesapeake Bay (Musick and Limpus 1997), Delaware Bay (Stetzar 2002), and Long Island Sound (Morreale and Standora 1993; Morreale *et al.* 2005). For instance, in the Chesapeake Bay, Kemp's ridleys frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus 1997). Upon leaving Chesapeake Bay in autumn, juvenile Kemp's ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined by juveniles of the same size from North Carolina and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Epperly *et al.* 1995a, 1995b; Musick and Limpus 1997).

Adult Kemp's ridleys are found in the coastal regions of the Gulf of Mexico and southeastern U.S., but are typically rare in the northeastern U.S. waters of the Atlantic (TEWG 2000). Adults are primarily found in nearshore waters of 68 meters or less (mean 33.2 ± 25.3 kilometers from shore) that are rich in crabs and have a sandy or muddy bottom (NMFS and USFWS 2015).

Population Dynamics and Status

The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; NMFS and USFWS 2007b; NMFS *et al.* 2011). There is a limited amount of scattered nesting to the north and south of the primary nesting beach (NMFS and USFWS 2015). Nesting often occurs in synchronized emergences termed *arribadas*. The number of recorded nests reached an estimated low of 702 nests in 1985, corresponding to fewer than 300 adult females nesting in that season (TEWG 2000; NMFS *et al.* 2011; NMFS and USFWS 2015). Conservation efforts by Mexican and U.S. agencies have aided this species by eliminating egg harvest, protecting eggs and hatchlings, and reducing at-sea mortality through fishing regulations (TEWG 2000). From the mid-1980s to the early 2000s, the number of nests observed at Rancho Nuevo and nearby beaches increased 14-16% per year (Heppell *et al.* 2005), allowing cautious optimism that the population was on its way to recovery. The total number of nests for all of Mexico was 22,458 in 2012 (the highest nesting total recorded since 1947), but fell back to 16,944 in 2013 and 12,060 in 2014. Based on an average of 2.5 nests per female per nesting season (NMFS *et al.* 2011), the total number of nests on Mexico beaches represented about 8,984 nesting females in 2012, 6,778 in 2013, and 4,824 in 2014 (NMFS and USFWS 2015). Similar to Mexico, Texas also experienced an overall increase in the number of nests since 2000. At Padre Island National Seashore, the number of observed nests hit an all-time high of 209 in 2012, but then fell back to 153 in 2013 and 119 in 2014 (NMFS and USFWS 2015).

Threats

Kemp's ridley sea turtles face many of the same natural threats as loggerheads, including destruction of nesting habitat from storm events, predators, and oceanographic-related events such as cold-stunning. Although cold-stunning can occur throughout the range of the species, it may be a greater risk for Kemp's ridleys that use the more northern habitats of Cape Cod Bay and Long Island Sound. From 2009-2013, the number of cold-stunned Kemp's ridleys on Massachusetts beaches averaged 185 turtles (NMFS unpublished data). The numbers ranged from a low of 132 in 2011 to a high of 235 in 2012. However, in 2014, the number of cold-stunned Kemp's ridleys documented in Massachusetts skyrocketed to 1,179, of which 466 died (NMFS unpublished data). As evidenced by this drastic increase, annual cold stun events can vary greatly in magnitude. The extent of episodic major cold stun events may be associated with numbers of sea turtles utilizing Northeast U.S. waters in a given year, oceanographic conditions, and/or the occurrence of storm events in the late fall. Although many cold-stunned turtles can survive if they are found early enough, these events represent a significant source of natural mortality for Kemp's ridley sea turtles.

Like other sea turtle species, the severe decline in the Kemp's ridley population appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940s through the early 1960s, nests from Ranch Nuevo were heavily exploited, but beach protection in 1967 helped to curtail this activity (NMFS *et al.* 2011). Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where adult Kemp's ridley sea turtles occur. Information from fisheries observers helped to demonstrate the high number of turtles captured in these shrimp trawls (USFWS and NMFS 1992). Subsequently, NMFS has worked with the industry to reduce sea turtle captures in shrimp trawls and other trawl fisheries, including the development and use of TEDs. As described above, there is lengthy regulatory history on the use of TEDs in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries (NMFS 2002; Epperly 2003; Lewison *et al.* 2003). The 2002 Opinion on shrimp trawling in the southeastern U.S. concluded that 155,503 Kemp's ridley sea turtles would be captured annually in the fishery with 4,208 of the captures resulting in mortality (NMFS 2002).

Although modifications to shrimp trawls have helped to reduce mortality of Kemp's ridleys, a recent assessment found that the Southeast/Gulf of Mexico shrimp trawl fishery remained responsible for the vast majority of U.S. fishery interactions (up to 98%) and mortalities (more than 80%). Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations. The most recent section 7 consultation on the shrimp fishery, completed in May 2012, was unable to estimate the total annual level of Kemp's ridley interactions occurring in the fishery. Instead, it qualitatively estimated that the shrimp fishery, as currently operating, would result in at least tens of thousands and possibly hundreds of thousands of interactions annually, of which at least thousands and possibly tens of thousands are expected to be lethal (NMFS 2012a).

This species is also affected by other sources of anthropogenic impact (fishery and non-fishery related), similar to those discussed above. One Kemp's ridley capture in Mid-Atlantic trawl fisheries was documented by NMFS observers between 2009 and 2013 (Murray 2015b), and five

Kemp's ridleys were documented by NMFS observers in Mid-Atlantic sink gillnet fisheries between 2007 and 2011 (Murray 2013). Additionally, in the spring of 2000, five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 275 loggerhead carcasses were found. The cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected by NMFS to have been from a large-mesh gillnet fishery for monkfish and dogfish operating offshore in the preceding weeks (67 FR 71895, December 3, 2002). The five Kemp's ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction, since it is unlikely that all of the carcasses washed ashore. The NEFSC also documented 14 Kemp's ridleys entangled in or impinged on Virginia pound net leaders from 2002-2005. Note that bycatch estimates for Kemp's ridleys in various fishing gear types (e.g., trawl, gillnet, dredge) are not available at this time, largely due to the low number of observed interactions precluding a robust estimate. Kemp's ridley interactions in non-fisheries have also been observed; for example, the Oyster Creek Nuclear Generating Station in Barnegat Bay, New Jersey, recorded a total of 56 Kemp's ridleys (36 of which were found alive) impinged or captured on their intake screens from 1992-2011 (NMFS 2011).

The recovery plan for Kemp's ridley sea turtles (NMFS *et al*. 2011) identifies climate change as a threat; however, as with the other species discussed above, no significant climate change-related impacts to Kemp's ridley sea turtles have been observed to date. Atmospheric warming could cause habitat alteration which may change food resources such as crabs and other invertebrates. It may increase hurricane activity, leading to an increase in debris in nearshore and offshore waters, which may result in an increase in entanglement, ingestion, or drowning. In addition, increased hurricane activity may cause damage to nesting beaches or inundate nests with sea water. Atmospheric warming may change convergence zones, currents, and other oceanographic features that are relevant to Kemp's ridleys, as well as change rain regimes and levels of nearshore runoff.

Considering that the Kemp's ridley has temperature-dependent sex determination (Wibbels 2003) and the vast majority of the nesting range is restricted to the State of Tamaulipas, Mexico, global warming could potentially shift population sex ratios towards females and thus change the reproductive ecology of this species. A female bias is presumed to increase egg production (assuming that the availability of males does not become a limiting factor) (Coyne and Landry 2007) and increase the rate of recovery; however, it is unknown at what point the percentage of males may become insufficient to facilitate maximum fertilization rates in a population. If males become a limiting factor in the reproductive ecology of the Kemp's ridley, then reproductive output in the population could decrease (Coyne 2000). Low numbers of males could also result in the loss of genetic diversity within a population; however, there is currently no evidence that this is a problem in the Kemp's ridley population (NMFS *et al*. 2011). Models (Davenport 1997, Hulin and Guillon 2007, Hawkes *et al*. 2007, all referenced in NMFS *et al*. 2011) predict very long-term reductions in fertility in sea turtles due to climate change, but due to the relatively long life cycle of sea turtles, reductions may not be seen until 30 to 50 years in the future.

Another potential impact from global climate change is sea level rise, which may result in increased beach erosion at nesting sites. Beach erosion may be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents. In the case of the Kemp's ridley where most of the critical nesting beaches are undeveloped, beaches may shift landward and still be available for nesting. The Padre Island National Seashore shoreline is accreting, unlike much of the Texas coast, and with nesting increasing and sand temperatures slightly cooler than at Rancho Nuevo, Padre Island could become an increasingly important source of males for the population.

As with the other sea turtle species discussed in this section, while there is a reasonable degree of certainty that certain climate change related effects will be experienced globally (e.g., rising temperatures and changes in precipitation patterns), due to a lack of scientific data, the specific effects of climate change on this species are not predictable or quantifiable at this time (Hawkes *et al*. 2009). Based on the most recent five-year status review (NMFS and USFWS 2015), and following from the climate change discussion on loggerheads, it is unlikely that impacts from climate change will have a significant effect on the status of Kemp's ridleys over the scope of the proposed action. However, significant impacts from climate change in the future are to be expected, but the severity of and rate at which these impacts will occur is currently unknown.

Summary of Status for Kemp's Ridley Sea Turtles
The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; NMFS *et al.* 2011; NMFS and USFWS 2015). The number of nesting females in the Kemp's ridley population declined dramatically from the late 1940s through the mid-1980s, with an estimated 40,000 nesting females in a single *arribada* in 1947 and fewer than 300 nesting females in the entire 1985 nesting season (TEWG 2000; NMFS *et al.* 2011). However, the total annual number of nests at Rancho Nuevo gradually began to increase in the 1990s (NMFS and USFWS 2015). Based on an average of 2.5 nests per female per nesting season (NMFS *et al.* 2011), the total number of nests on Mexico beaches represented about 4,824 nesting females in 2014 (NMFS and USFWS 2015).The number of adult males in the population is unknown, but sex ratios of hatchlings and immature Kemp's ridleys suggest that the population is female-biased, suggesting that the number of adult males is less than the number of adult females (NMFS and USFWS 2015). While there is cautious optimism for recovery, events such as the Deepwater Horizon oil release, and stranding events associated increased skimmer trawl use and poor TED compliance in the northern Gulf of Mexico may dampen recent population growth.

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction also contribute to annual human caused mortality, but the levels are unknown. Based on their five-year status review of the species, NMFS and USFWS (2015) determined that Kemp's ridley sea turtles should remain classified as endangered under the ESA. A revised bi-national recovery plan was published for public comment in 2010, and in September 2011, the NMFS, USFWS, and the Secretary of Environment and Natural Resources, Mexico (SEMARNAT) released the second revision to the Kemp's ridley recovery plan.

4.2.2.3 Status of Green Sea Turtles – North Atlantic DPS

Green sea turtles are distributed circumglobally, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters. They can be found in the Pacific, Indian, and

Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991, 2007d; Seminoff 2004; Seminoff *et al.* 2015). Their movements within the marine environment are not fully understood, but it is believed that green sea turtles inhabit coastal waters of over 140 countries (Groombridge and Luxmoore 1989).

Listing History

The green sea turtle was originally listed under the ESA on July 28, 1978 (43 FR 32800). Breeding populations of the green sea turtle in Florida and along the Pacific coast of Mexico were listed as endangered; while all other populations were listed as threatened. The major factors contributing to its status at the time included human encroachment and associated activities on nesting beaches; commercial harvest of eggs, subadults, and adults; predation; lack of comprehensive and consistent protective regulations; and incidental take in fisheries. Marine critical habitat for the green sea turtle was designated on September 2, 1998, for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys (63 FR 46693).

On April 6, 2016, the NMFS and USFWS issued a final determination that the green sea turtle is comprised of eleven DPSs, constituting the "species," to be listed as threatened or endangered under the ESA (81 FR 20058). Effective May 6, 2016, three DPSs were listed as endangered, eight as threatened. The April 2016 final rule replaced the 1978 global listing of green sea turtles.

In the final ESA listing decision, the NMFS and USFWS listed eleven green sea turtle DPSs distributed globally: (1) North Atlantic (threatened), (2) Mediterranean (endangered), (3) South Atlantic (threatened), (4) Southwest Indian (threatened), (5) North Indian (threatened), (6) East Indian-West Pacific (threatened), (7) Central West Pacific (endangered), (8) Southwest Pacific (threatened), (9) Central South Pacific (endangered), (10) Central North Pacific (threatened), and (11) East Pacific (threatened) (81 FR 20058; April 6, 2016). Based on the best available scientific and commercial data, only one listed DPS is likely to occur in the action area, the threatened North Atlantic DPS. The range of the North Atlantic DPS extends from the boundary of South and Central America, north along the coast to include Panama, Costa Rica, Nicaragua, Honduras, Belize, Mexico, and the U.S. It extends due east across the Atlantic Ocean at 48°N and follows the coast south to include the northern portion of the Islamic Republic of Mauritania (Mauritania) on the African continent to 19°N. It extends west at 19°N to the Caribbean basin to 65.1°W, then due south to 14°N, 65.1°W, then due west to 14°N, 77°W, and due south to 7.5°N, 77°W, the boundary of South and Central America. It includes Puerto Rico, the Bahamas, Cuba, Turks and Caicos Islands, Republic of Haiti, Dominican Republic, Cayman Islands, and Jamaica. The North Atlantic DPS includes the Florida breeding population, which was originally listed as endangered under the ESA (43 FR 32800; July 28, 1978).

In regards to discreteness, North Atlantic DPS populations of green sea turtles exhibit minimal mixing with the adjacent South Atlantic DPS and no mixing with the adjacent Mediterranean DPS. Occasionally, juvenile turtles from the North Atlantic may settle into foraging grounds in the South Atlantic or Mediterranean, while adult turtles nesting at sites in the equatorial region of the North Atlantic may travel to, and reside at, foraging grounds in the South Atlantic (Troëng *et al*. 2005). However, the reverse (i.e., turtles from the South Atlantic or Mediterranean DPS settling in North Atlantic waters) has yet to be documented. Furthermore, green sea turtles from the Mediterranean DPS appear to be spatially separated from populations in the Atlantic Ocean (Seminoff *et al*. 2015).

Distribution and Life History

Green sea turtles were once the target of directed fisheries in the U.S. and throughout the Caribbean. In 1890, over one million pounds of green sea turtles were captured in a directed fishery in the Gulf of Mexico (Doughty 1984). However, declines in the turtle fishery throughout the Gulf of Mexico were evident by 1902 (Doughty 1984).

In the North Atlantic, large juvenile and adult green sea turtles are largely herbivorous, occurring in habitats containing benthic algae and seagrasses from Massachusetts to Central America, including the Gulf of Mexico and Caribbean (Wynne and Schwartz 1999). Green sea turtles occur seasonally in U.S. Mid-Atlantic and Northeast waters such as Chesapeake Bay and Long Island Sound (Musick and Limpus 1997; Morreale and Standora 1998; Morreale *et al.* 2005), which serve as foraging and developmental habitats.

Some of the principal feeding areas in the North Atlantic Ocean include the upper west coast of Florida, the Florida Keys, and the northwestern coast of the Yucatán Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Fort Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, and the Caribbean coast of Panama (Hirth 1971).

Age at maturity for green sea turtles is estimated to be 20-50 years (Balazs 1982; Frazer and Ehrhart 1985; Seminoff 2004). Adult females may nest multiple times in a season (average three nests/season with approximately 100 eggs/nest) and typically do not nest in successive years (NMFS and USFWS 1991; Hirth 1997).

Population Dynamics and Status

Nest count information for green sea turtles provides information on the relative abundance of nesting, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The North Atlantic DPS contains an estimated 167,424 females nesting at 73 sites (81 FR 20058).

In 2015, the Green Turtle Status Review Team (SRT) identified those 73 nesting sites within the North Atlantic DPS, although some represent numerous individual beaches. There are four regions that support high density nesting concentrations for which data were available: Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), U.S. (Florida), and Cuba. Nester abundance was assessed by the SRT for 48 nesting sites within the North Atlantic DPS. Abundance was estimated using the best scientific information available. Remigration intervals and clutch frequencies were used to estimate total nester abundance when counts of nesters were not available. In terms of nester distribution, the largest nesting site (Tortuguero, Costa Rica) hosts 79% of total nester abundance (167,528 nesters). There were also 26 nesting sites for which there were qualitative reports of nesting activity but no nesting data: three in the Bahamas, three in Belize, one in Costa Rica, four in Cuba, one in the Dominican Republic, one in Haiti, six in Honduras, two in Jamaica, one in Mauritania, one in Panama, and three in the Turks and

Caicos Islands (Seminoff *et al.* 2015). Green turtle nesting populations in the North Atlantic are some of the most studied in the world, with time series exceeding 40 years in Costa Rica and 35 years in Florida. There are seven sites for which ten years or more of recent data are available for annual nester abundance.

By far, the most important nesting concentration for green sea turtles in the North Atlantic DPS is in Tortuguero, Costa Rica (Seminoff *et al.* 2015). This population has been studied since the 1950s and nesting has increased markedly since the early 1970s. From 1971 to 1975, there were approximately 41,250 nesting emergences per year and from 1992 to 1996 there were approximately 72,200 nesting emergences per year (Bjorndal *et al.* 1999). From 1999 to 2003, about 104,411 nests/year were deposited, which corresponds to approximately 17,402-37,290 nesting females each year (Troëng and Rankin 2005). An estimated 180,310 nests were laid during 2010, the highest level of green sea turtle nesting estimated since the start of nesting track surveys in 1971. This equates to 30,052-64,396 nesters in 2010. This increase has occurred despite substantial human impacts to the population at the nesting beach and at foraging areas (Troëng 1998; Campbell and Lagueux 2005; Troëng and Rankin 2005). The number of females nesting per year on beaches in Mexico, Florida, and Cuba number in the hundreds to low thousands, depending on the site (Seminoff *et al.* 2015).

The status of the Florida breeding population was also evaluated in the 2015 status review (Seminoff *et al.* 2015). In Florida, nesting occurs in coastal areas of all regions except the Big Bend area of west central Florida. The bulk of nesting occurs along the Atlantic coast of eastern central Florida, where a mean of 5,055 nests were deposited each year from 2001 to 2005 (Meylan *et al.* 2006) and 10,377 each year from 2008 to 2012 (B. Witherington, Florida Fish and Wildlife Conservation Commission, pers. comm., 2013). Nesting has increased substantially over the last 20 years and peaked in 2011 with 15,352 nests statewide (Chaloupka *et al.* 2008; B. Witherington, Florida Fish and Wildlife Conservation Commission, pers. comm., 2013). The estimated total nester abundance for Florida is 8,426 turtles.

The pattern of green sea turtle nesting shows biennial peaks in abundance, with a generally positive trend since establishment of the Florida index beach surveys in 1989. This trend is perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.* 1995), as well as protections in Florida and throughout the U.S. (Seminoff *et al.* 2015). The statewide Florida index beach surveys (1989-2015) have shown that green sea turtle nest counts have increased almost one hundredfold since 1989, from a low of 267 to a high of 27,975 in 2015 (http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). The last three odd-numbered years (2011, 2013, and 2015) have all broken previous records for the highest numbers of green sea turtle nests on Florida's index beaches.

Most nesting occurs along the east coast of Florida, but occasional nesting has been documented along the Gulf coast of Florida, at Southwest Florida beaches, as well as the beaches in the Florida Panhandle (Meylan *et al.* 1995). More recently, green sea turtle nesting occurred on Bald Head Island, North Carolina (just east of the mouth of the Cape Fear River), Onslow Island, and Cape Hatteras National Seashore. One green sea turtle nested on a beach in Delaware in 2011, although its occurrence was considered very rare.

Similar to the nesting trend found in Florida, in-water studies in Florida have also recorded increases in green sea turtle captures at the Indian River Lagoon site, with a 661% increase over 24 years (Ehrhart *et al.* 2007), and the St Lucie Power Plant site, with a significant increase in the annual rate of capture of immature green sea turtles (SCL<90 centimeters) from 1977 to 2002 or 26 years (3,557 green sea turtles total; Witherington *et al.* 2006).

Threats

Green sea turtles face many of the same natural threats as loggerhead and Kemp's ridley sea turtles. In addition, green sea turtles appear to be particularly susceptible to fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body. Juveniles appear to have the highest incidence of disease and the most extensive lesions, whereas lesions in nesting adults are rare. Also, green sea turtles frequenting nearshore waters, areas adjacent to large human populations, and areas with low water turnover, such as lagoons, have a higher incidence of the disease than individuals in deeper, more remote waters. The occurrence of fibropapilloma tumors may result in impaired foraging, breathing, or swimming ability, leading potentially to death (George 1997).

Incidental fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches. Witherington *et al.* (2009) observed that because green sea turtles spend a shorter time in oceanic waters, and as older juveniles occur on shallow seagrass pastures (where benthic trawling is unlikely), they avoid high mortalities in pelagic longline and benthic trawl fisheries. Although the relatively low number of observed green sea turtle captures makes it difficult to estimate bycatch rates and annual levels of interactions, green sea turtles have been observed captured in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and Mid-Atlantic trawl and gillnet fisheries. Two green sea turtle captures in Mid-Atlantic trawl fisheries was documented by NMFS observers between 2009 and 2013 (Murray 2015b), while Murray (2009) indicated that there were 12 observed captures of green sea turtles in Mid-Atlantic sink gillnet gear between 2007 and 2011.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations. The most recent section 7 consultation on the shrimp fishery, completed in May 2012, was unable to estimate the total annual level of green sea turtle interactions occurring in the fishery. Instead, it qualitatively estimated that the shrimp fishery, as currently operating, would result in at least hundreds and possibly low thousands of interactions annually, of which hundreds are expected to be lethal (NMFS 2012a).

Other activities like channel dredging, marine debris, pollution, vessel strikes, power plant impingement, and habitat destruction account for an unquantifiable level of other mortality. Stranding reports indicate that between 200-400 green sea turtles strand annually along the eastern U.S. coast from a variety of causes most of which are unknown (STSSN database).

The most recent five-year status review for green sea turtles (Seminoff *et al.* 2015) notes that global climate change is affecting the species and will likely continue to be a threat. There is an increasing female bias in the sex ratio of green sea turtle hatchlings. While this is partly attributable to imperfect egg hatchery practices, global climate change is also implicated as a likely cause, as warmer sand temperatures at nesting beaches are likely to result in the production of more female embryos. Climate change may also impact nesting beaches through sea level rise which may reduce the availability of nesting habitat and increase the risk of nest inundation. Loss of appropriate nesting habitat may also be accelerated by a combination of other environmental and oceanographic changes, such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion. Oceanic changes related to rising water temperatures could result in changes in the abundance and distribution of the primary food sources of green sea turtles, which in turn could result in changes in behavior and distribution of this species. Seagrass habitats may suffer from decreased productivity and/or increased stress due to sea level rise, as well as salinity and temperature changes (Short and Neckles 1999; Duarte 2002).

As noted above, the increasing female bias in green sea turtle hatchlings is thought to be at least partially linked to increases in temperatures at nesting beaches. However, due to a lack of scientific data, the specific future effects of climate change on green sea turtles species are not predictable or quantifiable to any degree at this time (Hawkes *et al*. 2009). For example, information is not available to predict the extent and rate to which sand temperatures at the nesting beaches used by green sea turtles may increase in the short-term future and the extent to which green sea turtles may be able to cope with this change by selecting cooler areas of the beach or shifting their nesting distribution to other beaches at which increases in sand temperature may not be experienced. Based on the most recent five-year status review (Seminoff *et al.* 2015), and following from the climate change discussions on the other hard-shelled sea turtle species, it is unlikely that impacts from climate change will have a significant effect on the status of green sea turtles over the scope of the action assessed in this Opinion. However, significant impacts from climate change in the future are to be expected, but the severity of and rate at which these impacts will occur is currently unknown.

Summary of Status for the North Atlantic DPS of Green Sea Turtles

In the North Atlantic, nesting groups are considered to be doing relatively well (i.e., the number of sites with increasing nesting are greater than the number of sites with decreasing nesting) (Seminoff *et al.* 2015). However, given the late age to maturity for green sea turtles, caution is urged regarding the status of nesting groups in the North Atlantic DPS since no area has a dataset spanning a full green sea turtle generation (Seminoff *et al.* 2015).

Seminoff *et al.* (2015) concluded that green sea turtle abundance is increasing for four nesting sites in the North Atlantic. They also concluded that nesting at Tortuguero, Costa Rica represents the most important nesting area for green sea turtles in the North Atlantic and that nesting at

Tortuguero has increased markedly since the 1970s (Seminoff *et al.* 2015). However, the five-year status review also noted that the Tortuguero nesting stock continues to be affected by ongoing directed captures at their primary foraging area in Nicaragua. The breeding population in Florida appears to be increasing rapidly in recent years based upon index nesting data from 1989-2015.

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like hopper dredging, pollution, and habitat destruction also contribute to human caused mortality, though the level is unknown.

4.2.2.4 Status of Leatherback Sea Turtles

Leatherback sea turtles are widely distributed throughout the oceans of the world, including the Atlantic, Pacific, and Indian Oceans, and the Mediterranean Sea (Ernst and Barbour 1972). Leatherbacks are the largest living turtles and range farther than any other sea turtle species. Their large size and tolerance of relatively low water temperatures allows them to occur in boreal waters such as those off Labrador and in the Barents Sea (NMFS and USFWS 1995).

In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard 1982). By 1995, this global population of adult females was estimated to have declined to 34,500 (Spotila *et al.* 1996). The most recent population size estimate for the North Atlantic alone is a range of 34,000-94,000 adult leatherbacks (TEWG 2007). Thus, there is substantial uncertainty with respect to global population estimates of leatherback sea turtles.

Pacific Ocean
Leatherback nesting has been declining at all major Pacific basin nesting beaches for the last two decades (Spotila *et al.* 1996, 2000; NMFS and USFWS 1998b, 2013; Sarti *et al.* 2000). The western Pacific major nesting beaches are in Papua New Guinea, Indonesia, Solomon Islands, and Vanuatu, with an approximate 2,700-4,500 total breeding females, estimated from nest counts (Dutton *et al.* 2007). While there appears to be overall long term population decline, the Indonesian nesting aggregation at Jamursba-Medi is currently stable (since 1999), although there is evidence to suggest a significant and continued decline in leatherback nesting in Papua New Guinea and Solomon Islands over the past 30 years (NMFS 2011). Leatherback sea turtles disappeared from India before 1930, have been virtually extinct in Sri Lanka since 1994, and appear to be approaching extinction in Malaysia (Spotila *et al.* 2000). In Fiji, Thailand, and Australia, leatherbacks have only been known to nest in low densities and scattered sites.

The largest, extant leatherback nesting group in the Indo-Pacific lies on the North Vogelkop coast of West Papua, Indonesia, with 3,000-5,000 nests reported annually in the 1990s (Suárez *et al.* 2000). However, in 1999, local villagers started reporting dramatic declines in sea turtles near their villages (Suárez 1999). Declines in nesting groups have been reported throughout the western Pacific region where observers report that nesting groups are well below abundance levels that were observed several decades ago (e.g., Suárez 1999).

Leatherback sea turtles in the western Pacific are threatened by poaching of eggs, killing of nesting females, human encroachment on nesting beaches, incidental capture in fishing gear, beach erosion, and egg predation by animals.

In the eastern Pacific Ocean, major leatherback nesting beaches are located in Mexico and Costa Rica, where nest numbers have been declining. According to reports from the late 1970s and early 1980s, beaches located on the Mexican Pacific coasts of Michoacán, Guerrero, and Oaxaca sustained a large portion, perhaps 50%, of all global nesting by leatherbacks (Sarti *et al.* 1996). A dramatic decline has been seen on nesting beaches in Pacific Mexico, where aerial survey data was used to estimate that tens of thousands of leatherback nests were laid on the beaches in the 1980s (Pritchard 1982), but a total of only 120 nests on the four primary index beaches (combined) were counted in the 2003-2004 season (Sarti Martinez *et al.* 2007). Since the early 1980s, the Mexican Pacific population of adult female leatherback turtles has declined to slightly more than 200 during 1998-1999 and 1999-2000 (Sarti *et al.* 2000). Spotila *et al.* (2000) reported the decline of the leatherback nesting at Playa Grande, Costa Rica, which had been the fourth largest nesting group in the world and the most important nesting beach in the Pacific. Between 1988 and 1999, the nesting group declined from 1,367 to 117 female leatherback sea turtles. An analysis of the Costa Rican nesting beaches indicates a decline in nesting during 15 years of monitoring (1989-2004) with approximately 1,504 females nesting in 1988-1989 to an average of 188 females nesting in 2000-2001 and 2003-2004 (NMFS and USFWS 2013), indicating that the reductions in nesting females were not as extreme as the reductions predicted by Spotila *et al.* (2000).

On September 26, 2007, NMFS received a petition to revise the critical habitat designation for leatherback sea turtles to include waters along the U.S. West Coast. On December 28, 2007, NMFS published a positive 90-day finding on the petition and convened a critical habitat review team. On January 26, 2012, NMFS published a final rule to revise the critical habitat designation to include three particular areas of marine habitat. The designation includes approximately 16,910 square miles along the California coast from Point Arena to Point Arguello east of the 3,000 meter depth contour, and 25,004 square miles from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour. The areas comprise approximately 41,914 square miles of marine habitat and include waters from the ocean surface down to a maximum depth of 262 feet. The designated critical habitat areas contain the physical or biological feature essential to the conservation of the species that may require special management conservation or protection. In particular, the team identified one Primary Constituent Element: the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae, of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

Leatherbacks in the eastern Pacific face a number of threats to their survival. For example, commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru; purse seine fisheries for tuna in the eastern tropical Pacific Ocean; and California/Oregon drift gillnet fisheries are known to capture, injure, or kill leatherbacks in the eastern Pacific. Given the declines in leatherback nesting in the Pacific, some researchers have concluded that the leatherback is on the verge of extinction in the Pacific Ocean (e.g., Spotila *et al.* 1996, 2000).

Indian Ocean
Leatherbacks nest in several areas around the Indian Ocean. These sites include Tongaland, South Africa (Pritchard 2002) and the Andaman and Nicobar Islands (Andrews *et al.* 2002). Intensive survey and tagging work in 2001 provided new information on the level of nesting in the Andaman and Nicobar Islands (Andrews *et al.* 2002). Based on the survey and tagging work, it was estimated that 400-500 female leatherbacks nest annually on Great Nicobar Island (Andrews *et al.* 2002). The number of nesting females using the Andaman and Nicobar Islands combined was estimated to be around 1,000 (Andrews and Shanker 2002). Some nesting also occurs along the coast of Sri Lanka, although in much smaller numbers than in the past (Pritchard 2002).

Mediterranean Sea
Casale *et al.* (2003) reviewed the distribution of leatherback sea turtles in the Mediterranean. Among the 411 individual records of leatherback sightings in the Mediterranean, there were no nesting records. Nesting in the Mediterranean is believed to be extremely rare if it occurs at all. Leatherbacks found in Mediterranean waters originate from the Atlantic Ocean (P. Dutton, NMFS, unpublished data).

Atlantic Ocean
Distribution and Life History
Evidence from tag returns and strandings in the western Atlantic suggests that adult leatherback sea turtles engage in routine migrations between northern temperate and tropical waters (NMFS and USFWS 1992). Leatherbacks are frequently thought of as a pelagic species that feed on jellyfish (e.g., *Stomolophus, Chryaora*, and *Aurelia* species) and tunicates (e.g., salps, pyrosomas) (Rebel 1974; Davenport and Balazs 1991). However, leatherbacks are also known to use coastal waters of the U.S. continental shelf (James *et al.* 2005a; Eckert *et al.* 2006; Murphy *et al.* 2006), as well as the European continental shelf on a seasonal basis (Witt *et al.* 2007).

Tagging and satellite telemetry data indicate that leatherbacks from the western North Atlantic nesting beaches use the entire North Atlantic Ocean (TEWG 2007). For example, leatherbacks tagged at nesting beaches in Costa Rica have been found in Texas, Florida, South Carolina, Delaware, and New York (STSSN database). Leatherback sea turtles tagged in Puerto Rico, Trinidad, and the Virgin Islands have also been subsequently found on U.S. beaches of southern, Mid-Atlantic, and northern states (STSSN database). Leatherbacks from the South Atlantic nesting assemblages (West Africa, South Africa, and Brazil) have not been re-sighted in the western North Atlantic (TEWG 2007).

The CETAP aerial survey of the outer continental shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia conducted between 1978 and 1982 showed leatherbacks to be present throughout the area with the most numerous sightings made from the Gulf of Maine south to Long Island. Leatherbacks were sighted in water depths ranging from one to 4,151 meters, but 84.4% of sightings were in waters less than 180 meters (Shoop and Kenney 1992). Leatherbacks were sighted in waters within a SST range similar to that observed for loggerheads; from 7° to 27.2°C (Shoop and Kenney 1992). However, leatherbacks appear to have a greater tolerance for colder waters in comparison to loggerhead sea turtles since more leatherbacks were found at the lower temperatures (Shoop and Kenney 1992). Studies of satellite tagged leatherbacks suggest that they spend 10-41% of their time at the surface, depending on the phase of their migratory cycle (James *et al.* 2005b). The greatest amount of surface time (up to 41%) was recorded when leatherbacks occurred in continental shelf and slope waters north of 38°N (James *et al.* 2005b).

In 1979, the waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands were designated as critical habitat for the leatherback sea turtle. On February 2, 2010, NMFS received a petition to revise the critical habitat designation for leatherback sea turtles to include waters adjacent to a major nesting beach in Puerto Rico. NMFS published a 90-day finding on the petition on July 16, 2010, which found that the petition did not present substantial scientific information indicating that the petitioned revision was warranted. The original petitioners submitted a second petition on November 2, 2010 to revise the critical habitat designation to again include waters adjacent to a major nesting beach in Puerto Rico, including additional information on the usage of the waters. NMFS determined on May 5, 2011, that a revision to critical habitat off Puerto Rico may be warranted, and an analysis is underway. Note that on August 4, 2011, the USFWS issued a determination that revision to critical habitat along Puerto Rico should be made and will be addressed during the future planned status review.

Leatherbacks are a long lived species (>30 years). They were originally believed to mature at a younger age than loggerhead sea turtles, with a previous estimated age at sexual maturity of about 13-14 years for females with nine years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (SEFSC 2001). However, new sophisticated analyses suggest that leatherbacks in the Northwest Atlantic may reach maturity at 24.5-29 years of age (Avens *et al.* 2009). In the U.S. and Caribbean, female leatherbacks nest from March through July. In the Atlantic, most nesting females average between 150-160 centimeters curved carapace length (CCL), although smaller (<145 centimeters CCL) and larger nesters are observed (Stewart *et al.* 2007; TEWG 2007). They nest frequently (up to seven nests per year) during a nesting season and nest about every two to three years. They produce 100 eggs or more in each clutch and can produce 700 eggs or more per nesting season (Schultz 1975). However, a significant portion (up to approximately 30%) of the eggs can be infertile. As is the case with other sea turtle species, leatherback hatchlings enter the water soon after hatching. Based on a review of all sightings of leatherback sea turtles of <145 centimeters CCL, Eckert (1999) found that leatherback juveniles remain in waters warmer than 26°C until they exceed 100 centimeters CCL.

Population Dynamics and Status

As described earlier, sea turtle nesting survey data is important because it provides information on the relative abundance of nesting, and the contribution of each population/subpopulation to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually, and as an indicator of the trend in the number of nesting females in the nesting group. The most recent five-year review for leatherback sea turtles (NMFS and USFWS 2013) compiled the most recent information on mean number of leatherback nests per year for each of the seven leatherback populations or groups of populations that were identified by the Leatherback TEWG as occurring within the Atlantic. These are: Florida, North Caribbean, Western Caribbean, Southern Caribbean, West Africa, South Africa, and Brazil (TEWG 2007).

In the U.S., the Florida Statewide Nesting Beach Survey program has documented an increase in leatherback nesting numbers from 98 nests in 1988 to between 800 and 900 nests in the early 2000s (NMFS and USFWS 2013). Stewart *et al.* (2011) evaluated nest counts from 68 Florida beaches over 30 years (1979-2008) and found that nesting increased at all beaches with trends ranging from 3.1%-16.3% per year, with an overall increase of 10.2% per year. An analysis of Florida's index nesting beach sites from 1989-2006 shows a substantial increase in leatherback nesting in Florida during this time, with an annual growth rate of approximately 1.17 (TEWG 2007). The TEWG reports an increasing or stable nesting trend for all of the seven populations or groups of populations, with the exceptions of the Western Caribbean and West Africa groups. The leatherback rookery along the northern coast of South America in French Guiana and Suriname supports the majority of leatherback nesting in the western Atlantic (TEWG 2007), and represents more than half of total nesting by leatherback sea turtles worldwide (Hilterman and Goverse 2004). Nest numbers in Suriname have shown an increase and the long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). The TEWG (2007) report indicates that a positive population growth rate was found for French Guinea and Suriname using nest numbers from 1967-2005, a 39-year period, and that there was a 95% probability that the population was growing. Given the magnitude of leatherback nesting in this area compared to other nest sites, negative impacts in leatherback sea turtles in this area could have profound impacts on the entire species.

The CETAP aerial survey conducted from 1978-1982 estimated the summer leatherback population for the northeastern U.S. at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina) (Shoop and Kenney 1992). However, the estimate was based on turtles visible at the surface and does not include those that were below the surface out of view. Therefore, it likely underestimated the leatherback population for the northeastern U.S. at the time of the survey. Estimates of leatherback abundance of 1,052 turtles and 1,174 turtles were obtained from surveys conducted from Virginia to the Gulf of St. Lawrence in 1995 and 1998, respectively (Palka 2000). However, since these estimates were also based on sightings at the surface, the author considered the estimates to be negatively biased and the true abundance of leatherbacks may be 4.27 times higher (Palka 2000).

Threats

The five-year status review (NMFS and USFWS 2013) and TEWG (2007) report provide summaries of natural as well as anthropogenic threats to leatherback sea turtles. Of the Atlantic sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, trap/pot gear in particular. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), their diving and foraging behavior, their distributional overlap with the gear, their possible attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the lightsticks used to attract target species in longline fisheries. Leatherbacks entangled in fishing gear generally have a reduced ability to feed, dive, surface to breathe, or perform any other behavior essential to survival (Balazs 1985). In addition to drowning from forced submergence, they may be more susceptible to boat strikes if forced to remain at the surface, and entangling lines can constrict blood flow resulting in tissue necrosis. The long-term impacts of entanglement on leatherback health remain unclear. Innis *et al.* (2010) conducted a health evaluation of leatherback sea turtles during direct capture (n=12) and disentanglement (n=7). They found no significant difference in many of the measured health parameters between entangled and directly captured turtles. However, blood parameters, including but not limited to sodium, chloride, and blood urea nitrogen, for entangled turtles showed several key differences that were most likely due to reduced foraging and associated seawater ingestion, as well as a general stress response.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations. The most recent section 7 consultation on the shrimp fishery, completed in May 2012, was unable to estimate the total annual level of leatherback interactions occurring in the fishery at present. Instead, it qualitatively estimated that the shrimp fishery, as currently operating, would result in a few hundred interactions annually, of which a subset are expected to be lethal (NMFS 2012a).

Leatherbacks have been documented interacting with longline, trap/pot, trawl, and gillnet fishing gear. For instance, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992 and 1999 (SEFSC 2001). Currently, the U.S. tuna and swordfish longline fisheries managed under the HMS FMP are estimated to capture 1,764 leatherbacks (no more than 252 mortalities) for each three-year period starting in 2007 (NMFS 2004a). In 2013, there were 72 observed interactions between leatherback sea turtles and longline gear used in the HMS fishery (Garrison and Stokes 2014). All leatherbacks were released alive, with all gear removed in 28 (39%) of the 72 captures. A total of 365.6 (95% CI: 270.2-494.8) leatherback sea turtles are estimated to have interacted with the longline fisheries managed under the HMS FMP in 2013 based on the observed bycatch events (Garrison and Stokes 2014). Compared to historical highs in 2004, the estimated take of leatherbacks has remained low and generally trended downward from 2007-2011, but then sharply increased in 2012 associated with an increase in reported fishing effort. The estimate for 2013 is lower than that for 2012 and is more consistent with estimates during the period from 2004-2011 (Garrison and Stokes 2014). The 2013 estimate remains well below the average prior to implementation of gear regulations (Garrison and Stokes 2014). Since the U.S. fleet accounts for only 5-8% of the longline hooks fished in the Atlantic Ocean, adding up the under-represented observed takes of the other 23 countries actively fishing in the area would likely result in annual take estimates of thousands of leatherbacks (SEFSC 2001). Lewison *et al*. (2004) estimated that 30,000-60,000 leatherbacks were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries).

Leatherbacks are susceptible to entanglement in the lines associated with trap/pot gear used in several fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine (Dwyer *et al.* 2002). Additional leatherbacks stranded wrapped in line of unknown origin or with evidence of a past entanglement (Dwyer *et al.* 2002). More recently, from 2002 to 2010, NMFS received 137 reports of sea turtles entangled in vertical lines from Maine to Virginia, with 128 events confirmed (verified by photo documentation or response by a trained responder; NMFS 2008a). Of the 128 confirmed events during this period, 117 events involved leatherbacks. NMFS identified the gear type and fishery for 72 of the 117 confirmed events, which included lobster (42[4]), whelk/conch (15), black sea bass (10), crab (2), and research pot gear (1). A review of leatherback mortality documented by the STSSN in Massachusetts suggests that vessel strikes and entanglement in fixed gear (primarily lobster pots and whelk pots) are the principal sources of this mortality (Dwyer *et al.* 2002).

Leatherback interactions with the U.S. South Atlantic and Gulf of Mexico shrimp fisheries are also known to occur (NMFS 2002). Leatherbacks are likely to encounter shrimp trawls working in the coastal waters off the U.S. Atlantic coast (from Cape Canaveral, Florida through North Carolina) as they make their annual spring migration north. For many years, TEDs that were required for use in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries were less effective for leatherbacks as compared to the smaller, hard-shelled turtle species, because the TED openings were too small to allow leatherbacks to escape. To address this problem, NMFS issued a final rule on February 21, 2003, to amend the TED regulations (68 FR 8456, February 21, 2003). Modifications to the design of TEDs are now required in order to exclude leatherbacks as well as large benthic immature and sexually mature loggerhead and green sea turtles. Given those modifications, Epperly *et al.* (2002) anticipated an average of 80 leatherback mortalities a year in shrimp gear interactions, dropping to an estimate of 26 leatherback mortalities in 2009 due to effort reduction in the Southeast shrimp fishery (Memo from Dr. B. Ponwith, SEFSC, to Dr. R. Crabtree, SERO, January 5, 2011).

Other trawl fisheries are also known to interact with leatherback sea turtles on a much smaller scale. In October 2001, for example, a NMFS fisheries observer documented the capture of a leatherback in a bottom otter trawl fishing for *Loligo* squid off Delaware. TEDs are not currently required in this fishery. In November 2007, fisheries observers reported the capture of a leatherback sea turtle in bottom otter trawl gear fishing for summer flounder. Four leatherback sea turtle captures in Mid-Atlantic trawl fisheries were documented by NMFS observers between 2009 and 2013 (Murray 2015b).

Gillnet fisheries operating in the waters of the Mid-Atlantic states are also known to capture, injure, and/or kill leatherbacks when these fisheries and leatherbacks co-occur. Data collected by the Northeast Fisheries Observer Program (NEFOP) from 1994-1998 (excluding 1997) indicate that a total of 37 leatherbacks were incidentally captured (16 lethally) in drift gillnets set in offshore waters from Maine to Florida during this period. Observer coverage for this period ranged from 54-92%. In North Carolina, six additional leatherbacks were reported captured in gillnet sets in the spring (SEFSC 2001). In addition to these, in September 1995, two dead leatherbacks were removed from an 11-inch (28.2-centimeter) monofilament shark gillnet set in the nearshore waters off of Cape Hatteras (STSSN unpublished data reported in SEFSC 2001).

[4] One case involved both lobster and whelk/conch gear.

Lastly, Murray (2013) reported one observed leatherback capture in Mid-Atlantic sink gillnet fisheries between 2007 and 2011.

Fishing gear interactions can occur throughout the range of leatherbacks, including in Canadian waters. Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland/Labrador were entangled in salmon nets, herring nets, gillnets, trawl lines, and crab pot lines. Leatherbacks are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo *et al.* 1994; Graff 1995). Gillnets are one of the suspected causes for the decline in the leatherback sea turtle population in French Guiana (Chevalier *et al.* 1999), and gillnets targeting green and hawksbill sea turtles in the waters of coastal Nicaragua also incidentally catch leatherback sea turtles (Lagueux 1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alio-M. 2000). An estimated 1,000 mature female leatherback sea turtles are caught annually in fishing nets off Trinidad and Tobago with mortality estimated to be between 50% and 95% (Eckert and Lien 1999). Many of the sea turtles do not die as a result of drowning, but rather because the fishermen butcher them to get them out of their nets (SEFSC 2001).

Leatherbacks may be more susceptible to marine debris ingestion than other sea turtle species due to the tendency of floating debris to concentrate in convergence zones that juveniles and adults use for feeding (Shoop and Kenney 1992; Lutcavage *et al.* 1997). Investigations of the necropsy results of leatherback sea turtles revealed that a substantial percentage (34% of the 408 leatherback necropsies' recorded between 1885 and 2007) reported plastic within the turtle's stomach contents, and in some cases (8.7% of those cases in which plastic was reported), blockage of the gut was found in a manner that may have caused the mortality (Mrosovsky *et al.* 2009). An increase in reports of plastic ingestion was evident in leatherback necropsies conducted after the late 1960s (Mrosovsky *et al.* 2009). Along the coast of Peru, intestinal contents of 19 of 140 (13%) leatherback carcasses were found to contain plastic bags and film (Fritts 1982). The presence of plastic debris in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items (e.g., jellyfish) and plastic debris (Mrosovsky 1981). Balazs (1985) speculated that plastic objects may resemble food items by their shape, color, size, or even movements as they drift about, and induce a feeding response in leatherbacks.

Global climate change has been identified as a factor that may affect leatherback habitat and biology (NMFS and USFWS 2013); however, no significant climate change related impacts to leatherback sea turtle populations have been observed to date. Over the long term, climate change related impacts will likely influence biological trajectories in the future on a century scale (Parmesan and Yohe 2003). Changes in marine systems associated with rising water temperatures, changes in ice cover, salinity, oxygen levels and circulation including shifts in ranges and changes in algal, plankton, and fish abundance could affect leatherback prey distribution and abundance. Climate change is expected to expand foraging habitats into higher latitude waters and some concern has been noted that increasing temperatures may increase the female:male sex ratio of hatchlings on some beaches (Mrosovsky *et al*. 1984 and Hawkes *et al*. 2007 in NMFS and USFWS 2013). However, due to the tendency of leatherbacks to have individual nest placement preferences and deposit some clutches in the cooler tide zone of beaches, the effects of long-term climate on sex ratios may be mitigated (Kamel and Mrosovsky 2004 in NMFS and USFWS 2013). Additional potential effects of climate change on leatherbacks include range expansion and changes in migration routes as increasing ocean temperatures shift range-limiting isotherms north (Robinson *et al*. 2008). Leatherbacks have expanded their range in the Atlantic north by 330 kilometers in the last few decades as warming has caused the northerly migration of the 15°C SST isotherm, the lower limit of thermal tolerance for leatherbacks (McMahon and Hays 2006). Leatherbacks are speculated to be the best able to cope with climate change of all the sea turtle species due to their wide geographic distribution and relatively weak beach fidelity. Leatherback sea turtles may be most affected by any changes in the distribution of their primary jellyfish prey, which may affect leatherback distribution and foraging behavior (NMFS and USFWS 2013). Jellyfish populations may increase due to ocean warming and other factors (Brodeur *et al*. 1999; Attrill *et al*. 2007; Richardson *et al*. 2009). However, any increase in jellyfish populations may or may not impact leatherbacks as there is no evidence that any leatherback populations are currently food-limited.

As discussed for the other three sea turtle species, increasing temperatures are expected to result in rising sea levels (Titus and Narayanan 1995 in Conant *et al*. 2009), which could result in increased erosion rates along nesting beaches. Sea level rise could result in the inundation of nesting sites and decrease available nesting habitat (Fish *et al*. 2005). This effect would potentially be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents. While there is a reasonable degree of certainty that climate change related effects will be experienced globally (e.g., rising temperatures and changes in precipitation patterns), due to a lack of scientific data, the specific effects of climate change on this species are not predictable or quantifiable at this time (Hawkes *et al*. 2009). Based on the most recent five-year status review (NMFS and USFWS 2013), and following from the climate change discussion in the previous sections on sea turtles, it is unlikely that impacts from climate change will have a significant effect on the status of leatherbacks over the scope of the action assessed in this Opinion. However, significant impacts from climate change in the future are to be expected, but the severity of and rate at which these impacts will occur is currently unknown.

Summary of Status for Leatherback Sea Turtles

In the Pacific Ocean, the abundance of leatherback sea turtles on nesting beaches has declined dramatically during the past 10 to 20 years. Nesting groups throughout the eastern and western Pacific Ocean have been reduced to a fraction of their former abundance due to human activities that have reduced the number of nesting females and reduced the reproductive success of females (for example, by egg poaching) (NMFS and USFWS 2013). No reliable long term trend data for the Indian Ocean populations are currently available. While leatherbacks are known to occur in the Mediterranean Sea, nesting in this region is not known to occur (NMFS and USFWS 2013).

Nest counts in many areas of the Atlantic Ocean show increasing trends, including for beaches in Suriname and French Guiana, which support the majority of leatherback nesting in this region (NMFS and USFWS 2013). The species as a whole continues to face numerous threats in nesting and marine habitats. As with the other sea turtle species, mortality due to fisheries interactions accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like pollution and habitat destruction account for an unknown level of other anthropogenic mortality. The long term recovery potential of this species may be further threatened by observed low genetic diversity, even in the largest nesting groups (NMFS and USFWS 2013).

Based on its five-year status review of the species, NMFS and USFWS (2013) determined that endangered leatherback sea turtles should not be delisted or reclassified. However, it also was determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified (NMFS and USFWS 2013).

4.2.3 Status of Shortnose Sturgeon

Shortnose sturgeon life history

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 centimeters fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell *et al.* 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[5] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse *et al.* 1987; Crowder *et al.* 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12-0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell *et al.* 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell *et al.* 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female and a mean of 11,568 eggs/kilogram body weight (Dadswell *et al.* 1984).

[5] For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the Minas Basin in Canada. Southern rivers are those south of the Chesapeake Bay down to Florida.

At hatching, shortnose sturgeon are blackish-colored, 7-11 millimeters long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15 millimeters total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20 millimeters TL. Dispersal rates differ at least regionally, laboratory studies on Connecticut River larvae indicated dispersal peaked 7-12 days after hatching in comparison to Savannah River larvae that had longer dispersal rates with multiple, prolonged peaks, and a low level of downstream movement that continued throughout the entire larval and early juvenile period (Parker 2007). Synder (1988) and Parker (2007) considered individuals to be juvenile when they reached 57 millimaters TL. Laboratory studies demonstrated that larvae from the Connecticut River made this transformation on day 40 while Savannah River fish made this transition on day 41 and 42 (Parker 2007).

The juvenile phase can be subdivided in to young of the year (YOY) and immature/sub-adults. YOY and sub-adult habitat use differs and is believed to be a function of differences in salinity tolerances. Little is known about YOY behavior and habitat use, though it is believed that they are typically found in channel areas within freshwater habitats upstream of the saltwedge for about one year (Dadswell *et al.* 1984, Kynard 1997). One study on the stomach contents of YOY revealed that the prey items found corresponded to organisms that would be found in the channel environment (amphipods) (Carlson and Simpson 1987). Sub-adults are typically described as age one or older and occupy similar spatio-temporal patterns and habitat-use as adults (Kynard 1997). However, there is evidence from the Delaware River that sub-adults may overwinter in different areas than adults and no not form dense aggregations like adults (ERC 2007). Sub-adults feed indiscriminately, typical prey items found in stomach contents include aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Dadswell 1979, Carlson and Simpson 1987, Bain 1997).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures reach between 7-9.7ºC, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Shotnose sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-kilometer reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-kilometer reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell *et al.* 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8º-15ºC, and bottom water velocities of 0.4 to 0.8 meters/second (Dadswell *et al.* 1984; Hall *et al.* 1991; Kieffer and Kynard 1996; NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.* 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell *et al.* 1984; Buckley and Kynard 1985; O'Herron *et al.* 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles or sub-adults tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes and move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell *et al.* 1984; Hall *et al.* 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell *et al.* 1984; Buckley and Kynard 1985; O'Herron *et al.* 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney *et al.* 1992; Rogers *et al.* 1994; Rogers and Weber 1995; Weber 1996).

While shortnose sturgeon do not undertake the significant marine migrations seen in Atlantic sturgeon, telemetry data indicates that shortnose sturgeon do make localized coastal migrations. This is particularly true within certain areas such as the Gulf of Maine and among rivers in the Southeast. Interbasin movements have been documented among rivers within the Gulf of Maine and between the Gulf of Maine and the Merrimack River, between the Connecticut and Hudson Rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

The temperature preference for shortnose sturgeon is not known (Dadswell *et al.* 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2º to 3ºC (Dadswell *et al.* 1984) and as high as 34ºC (Heidt and Gilbert 1978). However, temperatures above 28ºC are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28º-30ºC during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. Dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6 meters is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30 meters but are generally found in waters less than 20 meters (Dadswell 1979; Dadswell *et al.* 1984). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave *et al.* (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10 ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989).

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were "in peril…gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon. More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[6] of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially

[6] The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh *et al.* (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald *et al.* (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

Waldman *et al.* (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin *et al.* (2005) also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Minas Basin in Nova Scotia, Canada (NMFS 1998; Dadswell *et al.* 2013). Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers. Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, U.S. Geological Survey, pers. comm.; Dionne 2010), while the largest populations are found in the Saint John (~18,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain *et al.* 1998). As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard (1996) indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel *et al.* 1992; Collins *et al.* 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect 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. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also 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. 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 increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semi-volatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse effects" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semi-volatile 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 (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC. Flourney *et al.* (1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney *et al.*1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (Flourney *et al.* 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

4.2.4 Status of Atlantic Sturgeon

The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon, and then provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of the Atlantic sturgeon DPSs likely to occur in the action area and their use of the action area.

The Atlantic sturgeon is a subspecies of sturgeon distributed along the east coast of North America from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (Scott and Scott 1988; ASSRT 2007). NMFS has divided U.S. populations of Atlantic sturgeon into five DPSs: Gulf of Maine (GOM), New York Bight (NYB), Chesapeake Bay (CB), Carolina, and South Atlantic (SA) (77 FR 5880 and 77 FR 5914; Figure 1)[7]. The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King 2011). However, satellite tracking and tagging data demonstrate that Atlantic sturgeon from all five DPSs and Canada occur throughout the full range of the subspecies. Therefore, Atlantic sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine, and riverine environment that occur far from natal spawning rivers.
On February 6, 2012, NMFS published notice in the *Federal Register* that listed the NYB, CB, Carolina, and SA DPSs as “endangered,” and the GOM DPS as “threatened” (77 FR 5880 and 77 FR 5914). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, fish that originated in Canada are not included in the listings. As described below, individuals originating from all five of the listed DPSs may occur in the action area. Information general to all Atlantic sturgeon, as well as information specific to each of the DPSs, is provided below.

Life history
Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[8] fish (Bigelow and Schroeder 1953; Vladykov and Greeley 1963; Mangin 1964; Pikitch *et al.* 2005; Dadswell 2006; ASSRT 2007). They are relatively large fish, even amongst sturgeon species (Pikitch *et al.* 2005) and can grow to over 14 feet and weigh up to 800 pounds. Atlantic sturgeon are bottom feeders that suck food into a ventral protruding mouth (Bigelow and Schroeder 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder 1953; ASSRT 2007; Guilbard *et al.* 2007; Savoy 2007). Juvenile Atlantic sturgeon feed on aquatic insects, larvae, and other invertebrates (Bigelow and Schroeder 1953; ASSRT 2007; Guilbard *et al.* 2007). The life history of Atlantic sturgeon can be divided into five general categories as described in Table 4 below (adapted from ASSRT 2007).

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[7] To be considered for listing under the ESA, a group of organisms must constitute a “species.” A “species” is defined in section 3 of the ESA to include “any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.”
[8] Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn (NEFSC FAQ’s, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011)

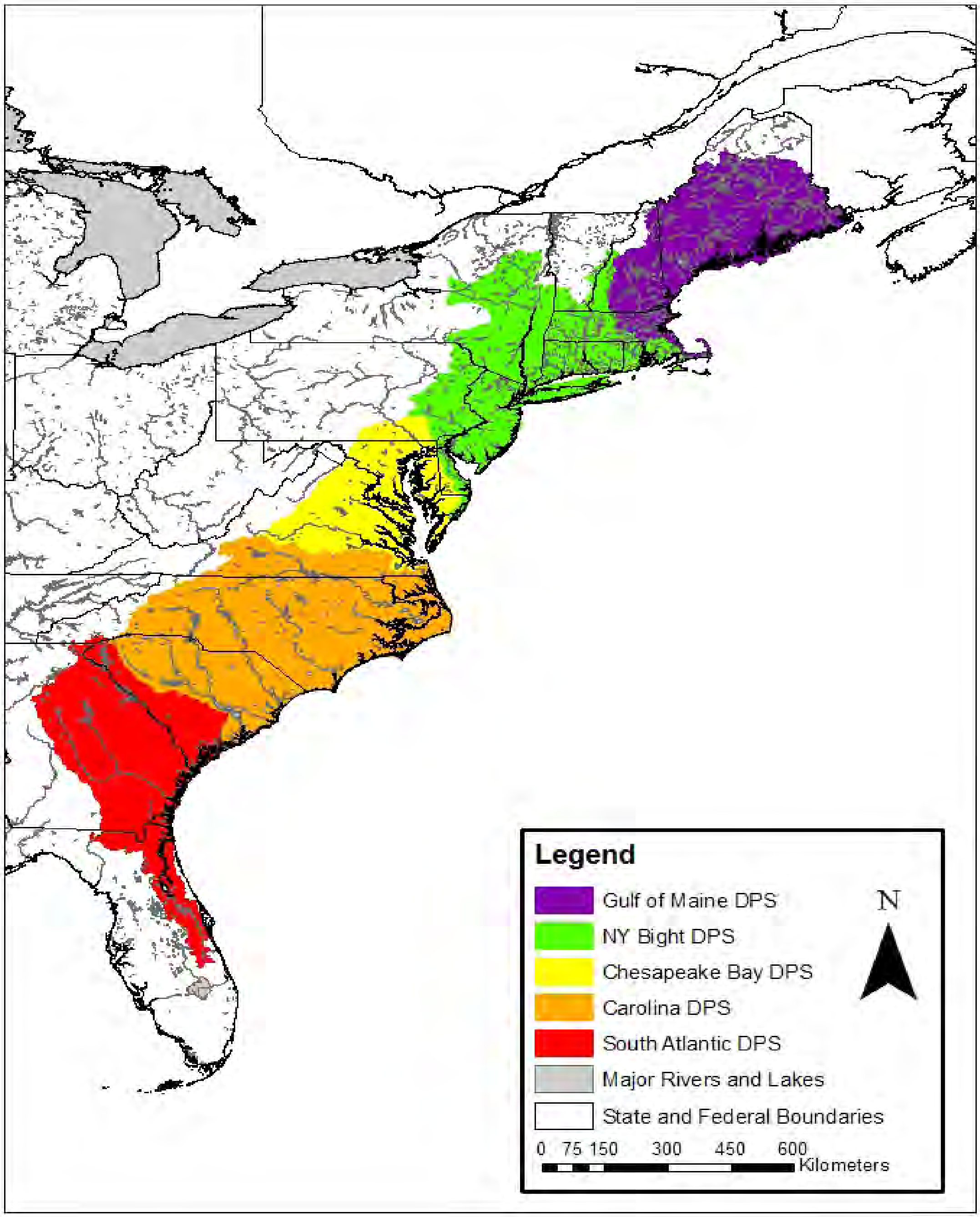


Figure 1. Map depicting the boundaries of the five Atlantic sturgeon DPSs.

Table 4. Descriptions of Atlantic sturgeon life history stages.

Age Class	Size	Description
Egg		Fertilized or unfertilized
Larvae		Negative photo-taxic, nourished by yolk sac
Young-of-the-Year (YOY)	**0.3 grams; <41 cm TL**	Fish that are > 3 months and < one year; capable of capturing and consuming live food
Sub-adults	**>41 cm and <150 cm TL**	Fish that are at least age 1 and are not sexually mature
Adults	**>150 cm TL**	Sexually mature fish

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e., length) than fully mature males. The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 meters (Vladykov and Greeley 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large-sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.* 1982; Van Eenennaam *et al.* 1996; Van Eenennaam and Doroshov 1998; Dadswell 2006). The lengths of Atlantic sturgeon caught since the mid-late 20th century have typically been less than three meters (Smith *et al.* 1982, Smith and Dingley 1984; Smith 1985; Scott and Scott 1988; Young *et al.* 1998; Collins *et al.* 2000; Caron *et al.* 2002; Dadswell 2006; ASSRT 2007; Kahnle *et al.* 2007; DFO 2011). While females are prolific, with egg production ranging from 400,000 to four million eggs per spawning year, females spawn at intervals of two to five years (Vladykov and Greeley 1963; Smith *et al.* 1982; Van Eenennaam *et al.* 1996; Van Eenennaam and Doroshov 1998; Stevenson and Secor 1999; Dadswell 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50% of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman 1997). Males exhibit spawning periodicity of one to five years (Smith 1985; Collins *et al.* 2000; Caron *et al.* 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (Greene *et al.* 2009). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco 1977; Smith 1985; Bain 1997; Smith and Clugston 1997; Caron *et al.* 2002). Male sturgeon begin upstream spawning migrations when waters reach approximately 6°C (43°F) (Smith *et al.* 1982; Dovel and Berggren 1983; Smith 1985; Greene *et al.* 2009), and remain on the spawning grounds throughout the spawning season (Bain 1997). Females begin spawning migrations when temperatures are closer to 12° to 13°C (54° to 55°F) (Dovel and Berggren 1983; Smith 1985; Collins *et al.* 2000), make rapid spawning migrations upstream, and quickly depart following spawning (Bain 1997).

The spawning areas in most U.S. rivers have not been well defined. However, the habitat characteristics of spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 centimeters/ second and depths are 3-27 meters (Borodin 1925; Dees 1961; Leland 1968; Scott and Crossman 1973; Crance 1987; Shirey *et al.* 1999; Bain *et al.* 2000; Collins *et al.* 2000; Caron *et al.* 2002; Hatin *et al.* 2002; Greene *et al.* 2009). Sturgeon eggs are deposited on hard bottom substrate such as cobble, coarse sand, and bedrock (Dees 1961; Scott and Crossman 1973; Gilbert 1989; Smith and Clugston 1997; Bain *et al.* 2000; Collins *et al.* 2000; Caron *et al.* 2002; Hatin *et al.* 2002; Mohler 2003; Greene *et al.* 2009), and become adhesive shortly after fertilization (Murawski and Pacheco 1977; Van den Avyle 1984; Mohler 2003). Incubation time for the eggs increases as water temperature decreases (Mohler 2003). At temperatures of 20° and 18°C, hatching occurs approximately 94 and 140 hours, respectively, after deposition (ASSRT 2007).

Larval Atlantic sturgeon (i.e., less than four weeks old, with TL less than 30 millimeters; Van Eenennaam *et al.* 1996) are assumed to mostly live on or near the bottom and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.* 1980; Bain *et al.* 2000; Kynard and Horgan 2002; Greene *et al.* 2009). Studies suggest that age-0 (i.e., YOY), age-1, and age-2 juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley 1999; Hatin *et al.* 2007; McCord *et al.* 2007; Munro *et al.* 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.* 2000). Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton 1973; Dovel and Berggen 1983; Waldman *et al.* 1996; Dadswell 2006; ASSRT 2007).

After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 meters in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley 1963; Murawski and Pacheco 1977; Dovel and Berggren 1983; Smith 1985; Collins and Smith 1997; Welsh *et al.* 2002; Savoy and Pacileo 2003; Stein *et al.* 2004a; Laney *et al.* 2007; Dunton *et al.* 2010; Erickson *et al.* 2011; Wirgin and King 2011). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 meters during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 meters in summer and fall (Erickson *et al.* 2011). A similar movement pattern for juvenile Atlantic sturgeon has been found based on recaptures of fish originally tagged in the Delaware River (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in Greene *et al.* 2009). After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras from November through early March. In the spring, a portion of the tagged fish re-entered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall. The majority of these tag returns were reported from relatively shallow nearshore fisheries with few fish reported from waters in excess of 25 meters (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in Greene *et al.* 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia/North Carolina border to Cape Hatteras at depths up to 24 meters (Dovel and Berggren 1983; Dadswell *et al.* 1984; Johnson *et al.* 1997; Rochard *et al.* 1997; Kynard *et al.* 2000; Eyler *et al.* 2004; Stein *et al.* 2004a; Wehrell 2005; Dadswell 2006; ASSRT 2007; Laney *et al.* 2007). These sites may be used as foraging sites and/or thermal refugia.

Determination of DPS Composition in the Action Area
As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. We have considered the best available information from a recent mixed stock analysis to determine from which DPSs individuals in the action area are likely to have originated. We have determined that Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: NYB 51.7%; SA 21.9%; CB 11.8%; GOM 10.1%; and Carolina 2.4%. Approximately 2.2% of the Atlantic sturgeon in the action area originate from Canadian rivers or management units. These percentages are based on genetic sampling of all individuals (n=173) captured during observed fishing trips along the Atlantic coast from Maine through North Carolina, and the results of the genetic analyses for these 173 fish were compared against a reference population of 411 fish and results for an additional 790 fish from other sampling efforts. Therefore, they represent the best available information on the likely genetic makeup of individuals occurring in the action area. The genetic assignments have corresponding 95% confidence intervals. However, for purposes of section 7 consultation, we have selected the reported values without their associated confidence intervals. The reported values, which approximate the mid-point of the range, are a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail in Wirgin *et al.* (2015).

Distribution and Abundance
Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19^{th} century when a caviar market was established (Scott and Crossman 1973; Taub 1990; MNRPD 1993; Smith and Clugston 1997; Dadswell 2006; ASSRT 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware River, and at least 10,000 females for other spawning stocks (Secor and Waldman 1999; Secor 2002). Historical records suggest that Atlantic sturgeon spawned in at least 35 rivers prior to this period. Currently, only 17 U.S. rivers are known to support spawning (i.e., presence of YOY or gravid Atlantic sturgeon documented within the past 15 years) (ASSRT 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only five rivers (Kennebec, Androscoggin, Hudson, Delaware, and James) are known to currently support spawning from Maine through Virginia, where historical records show that there used to be 15 spawning rivers (ASSRT 2007). Thus, there are substantial gaps between Atlantic sturgeon spawning rivers amongst northern and Mid-Atlantic states which could make recolonization of extirpated populations more difficult.

There are no current, published population abundance estimates for any of the currently known spawning stocks or for any of the five DPSs of Atlantic sturgeon. An estimate of 863 mature adults per year (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007). An estimate of 343 spawning adults per year is available for the Altamaha River, Georgia, based on fishery-independent data collected in 2004 and 2005 (Schueller and Peterson 2006). Using the data collected from the Hudson and Altamaha Rivers to estimate the total number of Atlantic sturgeon in either subpopulation is not possible, since mature Atlantic sturgeon may not spawn every year (Vladykov and Greeley 1963; Smith 1985; Van Eenennaam *et al.* 1996; Stevenson and Secor 1999; Collins *et al.* 2000; Caron *et al.* 2002), the age structure of these populations is not well understood, and stage to stage survival is unknown. In other words, the information that would allow us to take an estimate of annual spawning adults and expand that estimate to an estimate of the total number of individuals (e.g., yearlings, subadults, and adults) in a population is lacking. The ASSRT presumed that the Hudson and Altamaha Rivers had the most robust of the remaining U.S. Atlantic sturgeon spawning populations and concluded that the other U.S. spawning populations were likely less than 300 spawning adults per year (ASSRT 2007).

Lacking complete estimates of population abundance across the distribution of Atlantic sturgeon, the NEFSC developed a virtual population analysis model with the goal of estimating bounds of Atlantic sturgeon ocean abundance. The NEFSC suggested that cumulative annual estimates of surviving fishery discards could provide a minimum estimate of abundance. The objectives of producing the Atlantic Sturgeon Production Index (ASPI) were to characterize uncertainty in abundance estimates arising from multiple sources of observation and process error and to complement future efforts to conduct a more comprehensive stock assessment (Table 5). The ASPI provides a general abundance metric to assess risk for actions that may affect Atlantic sturgeon in the ocean; however, it is not a comprehensive stock assessment. In general, the model uses empirical estimates of post-capture survivors and natural survival, as well as probability estimates of recapture using tagging data from the USFWS sturgeon tagging database, and federal fishery discard estimates from 2006 to 2010 to produce a virtual population. The USFWS sturgeon tagging database is a repository for sturgeon tagging information on the Atlantic coast. The database contains tag release and recapture information from state and federal researchers. The database records recaptures by the fishing fleet, researchers, and researchers on fishery vessels.

In additional to the ASPI, a population estimate was derived from the NEAMAP trawl surveys (Table 5). The NEAMAP trawl surveys are conducted from Cape Cod, Massachusetts to Cape Hatteras, North Carolina in nearshore waters at depths up to 18.3 meters (60 feet) during the fall since 2007 and spring since 2008. Each survey employs a spatially stratified random design with a total of 35 strata and 150 stations. The Atlantic States Marine Fisheries Commission (ASMFC) has initiated a new stock assessment with the goal of completing it in the near future. NMFS will be partnering with them to conduct the stock assessment, and the ocean population abundance estimates produced by the NEFSC will be shared with the stock assessment committee for consideration in the stock assessment.

Table 5. Description of the ASPI model and NEAMAP survey based area estimate method.

Model Name	Model Description
A. ASPI	Uses tag-based estimates of recapture probabilities from 1999 to 2009. Natural mortality based on Kahnle *et al.* (2007) rather than estimates derived from tagging model. Tag recaptures from commercial fisheries are adjusted for non-reporting based on recaptures from observers and researchers. Tag loss assumed to be zero.
B. NEAMAP Swept Area	Uses NEAMAP survey-based swept area estimates of abundance and assumed estimates of gear efficiency. Estimates based on average of ten surveys from fall 2007 to spring 2012.

Atlantic sturgeon are frequently encountered during the NEAMAP surveys. The information from these surveys can be used to calculate minimum swept area population estimates within the strata swept by the surveys. The estimate from fall surveys ranges from 6,980 to 42,160 with coefficients of variation between 0.02 and 0.57, and the estimates from spring surveys ranges from 25,540 to 52,990 with coefficients of variation between 0.27 and 0.65 (Table 6). These are considered minimum estimates because the calculation makes the assumption that the gear will capture (i.e., net efficiency) 100% of the sturgeon in the water column along the tow path and that all sturgeon are with the sampling domain of the survey. We define catchability as: 1) the product of the probability of capture given encounter (i.e., net efficiency), and 2) the fraction of the population within the sampling domain. Catchabilities less than 100% will result in estimates greater than the minimum. The true catchability depends on many factors including the availability of the species to the survey and the behavior of the species with respect to the gear. True catchabilities much less than 100% are common for most species. The average ASPI estimate of 417,934 fish implies a catchability of between 6% and 13% for the spring NEAMAP surveys, and a catchability of between 2% and 10% for the fall NEAMAP surveys. If the availability of Atlantic sturgeon in the areas sampled by the spring NEAMAP surveys were say 50%, then the implied range of net efficiencies for this survey would double to 12% and 26%. The ratio of total sturgeon habitat to area sampled by the NEAMAP surveys is unknown, but is certainly greater than one.

Table 6. Annual minimum swept area estimates for Atlantic sturgeon during the spring and fall NEAMAP surveys. Estimates provided by Dr. Chris Bonzek (VIMS) and assume 100% net efficiencies.

Year	Fall Number	CV	Spring Number	CV
2007	6,981	0.015		
2008	33,949	0.322	25,541	0.391
2009	32,227	0.316	41,196	0.353
2010	42,164	0.566	52,992	0.265
2011	22,932	0.399	52,840	0.480
2012			28,060	0.652

The NEAMAP-based estimates do not include YOY fish and juveniles in the rivers; however, those segments of the Atlantic sturgeon populations are not at risk from the proposed actions since they do not occur within the action area. The NEAMAP surveys are conducted in waters that include the preferred depth ranges of subadult and adult Atlantic sturgeon and take place during seasons that coincide with known Atlantic sturgeon coastal migration patterns in the ocean. Therefore, the NEAMAP estimates are minimum estimates of the ocean population of Atlantic sturgeon but are based on sampling throughout the action area, in known sturgeon coastal migration areas during times that sturgeon are expected to be migrating north and south.

Available data do not support estimation of true catchabilty (i.e., net efficiency x availability) of the NEAMAP trawl survey for Atlantic sturgeon. Thus, the NEAMAP swept area biomass estimates were produced and presented for catchabilities from 5% to 100%. Assuming the NEAMAP surveys have been 100% efficient would require the unlikely assumption that the survey gear captures all Atlantic sturgeon within the path of the trawl and all sturgeon are within the sampling area of the NEAMAP survey. The 50% efficiency assumption seems to reasonably account for the robust, yet not complete sampling of the Atlantic sturgeon oceanic temporal and spatial ranges and the documented high rates of encounter with NEAMAP survey gear and Atlantic sturgeon. For this Opinion, we have determined that the best available data at this time are the population estimates derived from NEAMAP swept area biomass resulting from the 50% catchability rate (Table 7). The estimates are derived directly from empirical data with fewer assumptions than have been required to model Atlantic sturgeon populations to date.

Table 7. Modeled results from the ASPI and NEAMAP Atlantic sturgeon estimation methods.

Model Run	**Model Years**	**95% low**	**Mean**	**95% high**
A. ASPI	1999-2009	165,381	417,934	744,597
B.1 NEAMAP Survey, swept area assuming 100% efficiency	2007-2012	8,921	33,888	58,856
B.2 NEAMAP Survey, swept area assuming 50% efficiency	2007-2012	13,962	67,776	105,984
B.3 NEAMAP Survey, swept area assuming 10% efficiency	2007-2012	89,206	338,882	588,558

The ocean population abundance of 67,776 fish estimated from the NEAMAP surveys assuming 50% efficiency (Table 7) was subsequently partitioned by DPS based on genetic frequencies of occurrence (Table 8). Given the proportion of adults to subadults in the observer database (approximate ratio of 1:3), we have also estimated a number of subadults originating from each DPS (Table 8). However, this cannot be considered an estimate of the total number of subadults because it only considers those subadults that are of a size vulnerable to capture in commercial gillnet and trawl gear in the marine environment and are present in the marine environment.

Table 8. Summary of calculated population estimates based upon the NEAMAP survey swept area model assuming 50% efficiency.

DPS	Estimated Ocean Population Abundance	Estimated Ocean Population of Adults	Estimated Ocean Population of Subadults (of size vulnerable to capture in fisheries)
GOM (11%)	7,455	1,864	5,591
NYB (49%)	33,210	8,303	24,907
CB (14%)	9,489	2,372	7,117
Carolina (4%)	2,711	678	2,033
SA (20%)	13,555	3,389	10,166
Canada (2%)	1,356	339	1,017

Threats

Atlantic sturgeon are susceptible to over exploitation given their life history characteristics (e.g., late maturity, dependence on a wide-variety of habitats). Similar to other sturgeon species (Vladykov and Greeley 1963; Pikitch *et al.* 2005), Atlantic sturgeon experienced range-wide declines from historical abundance levels due to overfishing (for caviar and meat) and impacts to habitat in the 19th and 20th centuries (Taub 1990; Smith and Clugston 1997; Secor and Waldman 1999).

Because a DPS is a group of populations, the stability, viability, and persistence of individual populations affects the persistence and viability of the larger DPS. The loss of any population within a DPS could result in: (1) a long-term gap in the range of the DPS that is unlikely to be recolonized; (2) loss of reproducing individuals; (3) loss of genetic biodiversity; (4) loss of unique haplotypes; (5) loss of adaptive traits; and (6) reduction in total number. The loss of a population will negatively impact the persistence and viability of the DPS as a whole, as fewer than two individuals per generation spawn outside their natal rivers (Secor and Waldman 1999). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, emigration to marine habitats to grow, and return of adults to natal rivers to spawn.

Based on the best available information, NMFS has concluded that unintended catch in fisheries, vessel strikes, poor water quality, freshwater availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon (77 FR 5880 and 77 FR 5914; February 6, 2012). While all the threats are not necessarily present in the same area at the same time, given that Atlantic sturgeon subadults and adults use ocean waters from Labrador, Canada to Cape Canaveral, Florida, as well as estuaries of large rivers along the U.S. East Coast, activities affecting these water bodies are likely to impact more than one Atlantic sturgeon DPS. In addition, because Atlantic sturgeon depend on a variety of habitats, every life stage is likely affected by one or more of the identified threats.

Atlantic sturgeon are particularly sensitive to bycatch mortality because they are a long-lived species, have an older age at maturity, have lower maximum fecundity values, and a large percentage of egg production occurs later in life. Based on these life history traits, Boreman (1997) calculated that Atlantic sturgeon can only withstand the annual loss of up to 5% of their population to bycatch mortality without suffering population declines. Mortality rates of Atlantic sturgeon taken as bycatch in various types of fishing gear range between 0% and 51%, with the greatest mortality occurring in sturgeon caught by sink gillnets. Atlantic sturgeon are particularly vulnerable to being caught in sink gillnets; therefore, fisheries using this type of gear account for a high percentage of Atlantic sturgeon bycatch. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low dissolved oxygen). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging, anadromous species, Atlantic sturgeon are subject to numerous Federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms, including the prohibition on possession, have addressed impacts to Atlantic sturgeon through directed fisheries, there are currently insufficient mechanisms in place to address the significant risk posed to Atlantic sturgeon from commercial bycatch.

An ASMFC interstate fishery management plan for sturgeon (Sturgeon FMP) was developed and implemented in 1990 (Taub 1990). In 1998, the remaining Atlantic sturgeon fisheries in U.S. state waters were closed per Amendment 1 to the Sturgeon FMP. NMFS implemented complementary regulations in 1999 that prohibit fishing for, harvesting, possessing, or retaining Atlantic sturgeon or their parts in or from the EEZ in the course of a commercial fishing activity.

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters (DFO 2011). Sturgeon belonging to one or more of the DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the GOM and the NYB DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO 2011; Wirgin and King 2011). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), 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. At this time, there are no estimates of the number of individuals from any of the DPSs that are captured or killed in Canadian fisheries each year. Based on geographic distribution, most U.S. Atlantic sturgeon that are intercepted in Canadian fisheries are likely to originate from the GOM DPS, with a smaller percentage from the NYB DPS.

Fisheries bycatch in U.S. waters is the primary threat faced by all five DPSs. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Federal FMPs (NEFSC 2011b) in the Greater Atlantic Region but do not have a similar estimate for Southeast fisheries. We also do not have an estimate of the number of Atlantic sturgeon captured or killed in state fisheries. At this time, we are not able to quantify the effects of other significant threats (e.g., vessel strikes, poor water quality, water availability, dams, and dredging) in terms of habitat impacts or loss of individuals. While we have some information on the number of mortalities that have occurred in the past in association with certain activities (e.g., mortalities in the Delaware and James Rivers that are thought to be due to vessel strikes), we are not able to use those numbers to extrapolate effects throughout one or more DPS. This is because of (1) the small number of data points and, (2) lack of information on the percent of incidences that the observed mortalities represent.

As noted above, the NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by Northeast FMPs (NEFSC 2011b). The analysis estimates that from 2006-2010 there were averages of 1,548 and 1,569 encounters per year in observed gillnet and trawl fisheries, respectively, with an average of 3,118 encounters combined annually. Mortality rates in gillnet gear were approximately 20%. Mortality rates in otter trawl gear were generally lower at approximately 5%.

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to affect the SA and Carolina DPSs. Implications of climate change to the Atlantic sturgeon DPSs have been speculated, yet no scientific data are available on past trends related to climate effects on this species, and current scientific methods are not able to reliably predict the future magnitude of climate change and associated impacts or the adaptive capacity of these species. Impacts of climate change on Atlantic sturgeon are uncertain at this time, and cannot be quantified. Any prediction of effects is made more difficult by a lack of information on the rate of expected change in conditions and a lack of information on the adaptive capacity of the species (i.e., its ability to evolve to cope with a changing environment). For analysis on the potential effects of climate change on Atlantic sturgeon, see Section 5.3.4 below.

4.2.4.1 Gulf of Maine DPS of Atlantic sturgeon

The GOM DPS includes the following: all anadromous Atlantic sturgeon that spawn or are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, Massachusetts. The marine range of Atlantic sturgeon from the GOM DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the GOM DPS and the adjacent portion of the marine range are shown in Figure 1. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT 2007). Spawning still occurs in the Kennebec and Androscoggin Rivers, and it is possible that it still occurs in the Penobscot River as well. Spawning in the Androscoggin River was just recently confirmed by the Maine Department of Marine Resources when they captured a larval Atlantic sturgeon during the 2011 spawning season below the Brunswick Dam. There is no evidence of recent spawning in the remaining rivers. In the 1800s, construction of the Essex Dam on the

Merrimack River at river kilometer (rkm) 49 blocked access to 58% of Atlantic sturgeon habitat in the river (Oakley 2003; ASSRT 2007). However, the accessible portions of the Merrimack seem to be suitable habitat for Atlantic sturgeon spawning and rearing (i.e., nursery habitat) (Kieffer and Kynard 1993). Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in the Merrimack River. Studies are on-going to determine whether Atlantic sturgeon are spawning in the Penobscot and Saco Rivers. Atlantic sturgeon that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT 2007).

At its mouth, the Kennebec River drains an area of 24,667 square kilometers, and is part of a large estuarine system that includes the Androscoggin and Sheepscot Rivers (ASMFC 1998a; ASSRT 1998; Squiers 1998). The Kennebec and Androscoggin Rivers flow into Merrymeeting Bay, a tidal freshwater bay, and exit as a combined river system through a narrow channel, flowing approximately 32 kilometers (20 miles) to the Atlantic Ocean as the tidal segment of the Kennebec River (Squiers 1998). This lower tidal segment of the Kennebec River forms a complex with the Sheepscot River estuary (ASMFC 1998a; Squiers 1998).

Substrate type in the Kennebec estuary is largely sand and bedrock (Fenster and FitzGerald 1996; Moore and Reblin 2010). Main channel depths at low tide typically range from 17 meters (58 feet) near the mouth to less than 10 meters (33 feet) in the Kennebec River above Merrymeeting Bay (Moore and Reblin 2010). Salinities range from 31 parts per thousand at Parker Head (five kilometers from the mouth) to 18 parts per thousand at Doubling Point during summer low flows (ASMFC 1998a). The 14-kilometer river segment above Doubling Point to Chops Point (the outlet of Merrymeeting Bay) is an area of transition (mid estuary) (ASMFC 1998a). The salinities in this section vary both seasonally and over a tidal cycle. During spring freshets this section is entirely fresh water but during summer low flows, salinities can range from two to three parts per thousand at Chops Point to 18 ppt at Doubling Point (ASMFC 1998a). The river is essentially tidal freshwater from the outlet of Merrymeeting Bay upriver to the site of the former Edwards Dam (ASMFC 1998a). Mean tidal amplitude ranges from 2.56 meters at the mouth of the Kennebec River estuary to 1.25 meters in Augusta near the head of tide on the Kennebec River (in the vicinity of the former Edwards Dam) and 1.16 meters at Brunswick on the Androscoggin River (ASMFC 1998a).

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (Squiers *et al.* 1981; ASMFC 1998a; ASSRT 1998). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (i.e., expressing milt) in July 1994 below the (former) Edwards Dam; (2) the capture of 31 adult Atlantic sturgeon from June 15 through July 26, 1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least four ripe males and one ripe female captured on July 26, 1980; and, (3) the capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, Maine (ASSRT 1998; ASMFC TC 2007). The low salinity values for waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

Age to maturity for GOM DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is 11 to 21 years for Atlantic sturgeon originating from the Hudson River (Young *et al.* 1998), and 22 to 34 years for Atlantic sturgeon that originate from the Saint Lawrence River (Scott and Crossman 1973). Therefore, age at maturity for Atlantic sturgeon of the GOM DPS likely falls within these values. Of the 18 sturgeon examined from the commercial fishery that occurred in the Kennebec River in 1980, all of which were considered mature, age estimates for the 15 males ranged from 17-40 years, and from 25-40 years old for the three females (Squiers *et al.* 1981).

Several threats play a role in shaping the current status of GOM DPS Atlantic sturgeon. Historical records provide evidence of commercial fisheries for Atlantic sturgeon in the Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers *et al.* 1979). In 1849, 160 tons of sturgeon was caught in the Kennebec River by local fishermen (Squiers *et al.* 1979). After the collapse of sturgeon stock in the 1880s, the sturgeon fishery was almost non-existent. All directed Atlantic sturgeon fishing as well as retention of Atlantic sturgeon bycatch has been prohibited since 1998. Nevertheless, mortalities associated with bycatch in fisheries in state and Federal waters still occurs. In the marine range, GOM DPS Atlantic sturgeon are incidentally captured in Federal and state-managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.* 2004b; ASMFC TC 2007). As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Many rivers in the GOM DPS have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the GOM DPS. While some dredging projects operate with observers present to document fish mortalities, many do not. To date we have not received any reports of Atlantic sturgeon killed during dredging projects in the Gulf of Maine region. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects are also not able to quantify any effects to habitat.

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin, and Saco Rivers, these dams are near the site of historical natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown; however, the documentation of an 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 project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Milford Dam, at the base of which is the presumed historical spawning habitat. Atlantic sturgeon are known to occur in the Penobscot River, but it is unknown if spawning is currently occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. As with the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning in this river.

GOM DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Gulf of Maine over the past decades (Lichter *et al.* 2006; EPA 2008). Many rivers in Maine, including the Androscoggin River, were heavily polluted in the past from pulp and paper mill industrial discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds, as developing eggs and larvae are particularly susceptible to exposure to contaminants.

There are no direct in-river abundance estimates for the GOM DPS. The Atlantic Sturgeon Status Review Team (ASSRT 2007) presumed that the GOM DPS was comprised of less than 300 spawning adults per year, based on extrapolated abundance estimates from the Hudson and Altamaha riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized, adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies. As described earlier in Section 4.2.4, we have estimated that there are a minimum of 7,455 GOM DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in the action area. We note further that this estimate is predicated on the assumption that fish in the GOM DPS would be available for capture in the NEAMAP surveys which extend from Block Island Sound, Rhode Island southward. Recoveries of tagged sturgeon do not support this migration pattern.

Summary of the Gulf of Maine DPS

Spawning for the GOM DPS is known to occur in two rivers (Kennebec and Androscoggin). Spawning may be occurring in other rivers, such as the Sheepscot, Merrimack, and Penobscot, but has not been confirmed. There are indications of potential increasing abundance of Atlantic sturgeon belonging to the GOM DPS. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River, and are observed in rivers where they were unknown to occur or had not been observed to occur for many years (e.g., Saco, Presumpscot, and Charles Rivers). 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 this DPS.

Some of the impacts from the threats that contributed to the decline of the GOM DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999 and the Veazie Dam on the Penobscot River in 2013). In Maine state waters, there are strict regulations on the use of fishing gear that incidentally catches sturgeon. In addition, in the last several years there have been reductions in fishing effort in state and Federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC TC 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, Massachusetts, with only 8% (e.g., 7 of 84 fish) of interactions observed south of Chatham being assigned to the GOM DPS (Wirgin and King 2011). Tagging results also indicate that GOM DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south.

Data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy (Canada) indicate that approximately 35% originated from the GOM DPS (Wirgin *et al.* 2012). Thus, a significant number of the GOM DPS fish appear to migrate north into Canadian waters where they may be subjected to a variety of threats including bycatch.

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman 1997; ASMFC TC 2007; Kahnle *et al*. 2007; Brown and Murphy 2010). We have determined that the GOM DPS is at risk of becoming endangered in the foreseeable future throughout all of its range (i.e., is a threatened species) based on the following: (1) significant declines in population sizes and the protracted period during which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect recovery.

4.2.4.2 New York Bight DPS of Atlantic sturgeon

The NYB DPS includes the following: all anadromous Atlantic sturgeon that spawn or are spawned in the watersheds that drain into coastal waters from Chatham, Massachusetts to the Delaware-Maryland border on Fenwick Island. The marine range of Atlantic sturgeon from the NYB DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the NYB DPS and the adjacent portion of the marine range are shown in Figure 1. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco 1977; Secor 2002; ASSRT 2007). Spawning still occurs in the Delaware and Hudson Rivers, but there is no recent evidence (within the last 15 years) of spawning in the Connecticut and Taunton Rivers (ASSRT 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT 2007; Savoy 2007; Wirgin and King 2011).

The abundance of the Hudson River Atlantic sturgeon riverine population before the over-exploitation of the 1800s is unknown, but has been conservatively estimated at 6,000 adult females (Secor 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor 2002; ASSRT 2007; Kahnle *et al.* 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007). Kahnle *et al.* (1998, 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid-1970s (Kahnle *et al.* 1998). A decline appeared to occur in the mid to late 1970s followed by a secondary drop in the late 1980s (Kahnle *et al.* 1998; Sweka *et al.* 2007; ASMFC 2010). Catch-per-unit-effort (CPUE) data suggests that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980s (Sweka *et al.* 2007; ASMFC 2010). The CPUE data from 1985-2011 show significant fluctuations. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and then a slight increase in the 2000s, but, given the significant annual fluctuation, it is difficult to discern any trend. Despite the CPUEs from 2000-2011 being slightly higher than those from 1990-1999, they are low compared to the late 1980s (Figure 2). There is currently not enough information regarding any life stage to establish a trend for the Hudson River population.

There is no overall, empirical abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800s indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman 1999; Secor 2002). Sampling in 2009 to target YOY Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 YOY, ranging in size from 178 to 349 millimeters TL (Fisher 2009), and the collection of 32 YOY Atlantic sturgeon in a separate study (Brundage and O'Herron 2009 in Calvo *et al.* 2010). Genetics information collected from 33 of these YOY indicates that at least three females successfully contributed to the 2009 year class (Fisher 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning still occurs in the Delaware River, the relatively low numbers suggest the existing riverine population is small.

Several threats play a role in shaping the current status and trends observed in the Delaware River and Estuary. In-river threats include habitat disturbance from dredging, and impacts from historical pollution and impaired water quality. A dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron 2009), and the river receives significant shipping traffic. Vessel strikes have been identified as a threat in the Delaware River and may be detrimental to the long-term viability of the NYB DPS, as well as other DPSs (Brown and Murphy 2010).

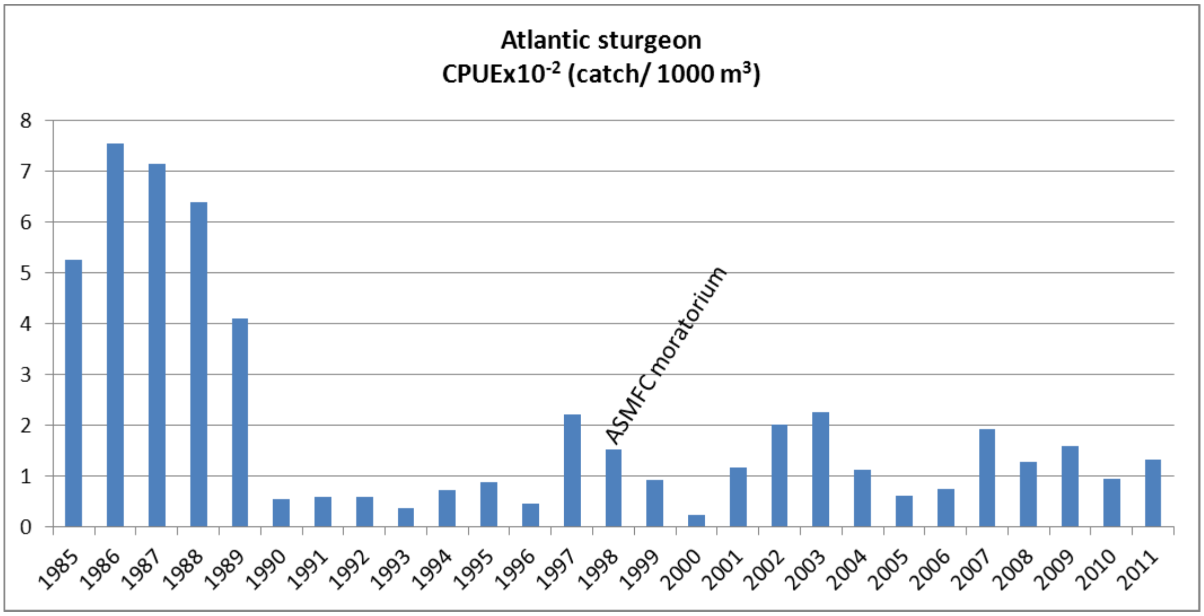


Figure 2. Hudson River Atlantic sturgeon CPUE juvenile index (1985-2011).

Summary of the New York Bight DPS

Atlantic sturgeon originating from the NYB DPS have been documented to spawn in the Hudson and Delaware Rivers and may spawn in the Connecticut and Housatonic Rivers, although that has not been confirmed. While genetic testing can differentiate between individuals originating from the Hudson or Delaware River, the available information suggests that the straying rate is relatively high between these rivers. Some of the impact from the threats that contributed to the decline of the NYB DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and Federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes remain significant threats to the NYB DPS.

In its marine range, NYB DPS Atlantic sturgeon are incidentally captured in Federal and state-managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.* 2004a; ASMFC TC 2007). Based on mixed stock analysis results presented by Wirgin and King (2011), more than 40% of the Atlantic sturgeon bycatch interactions in the Mid-Atlantic Bight region were sturgeon from the NYB DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the NYB DPS (Wirgin *et al*. 2012). At this time, we are not able to quantify the impacts from threats other than fisheries or estimate the number of individuals killed as a result of other anthropogenic threats.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Both the Hudson and Delaware Rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities, many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey. We have recently consulted on two Army Corps of Engineers (ACOE) dredging projects: (1) the Delaware River Federal Navigation Channel deepening project and (2) the New York and New Jersey Harbor Deepening Project. In both cases, we determined that while the proposed actions may adversely affect Atlantic sturgeon, they were not likely to jeopardize the continued existence of any DPS of Atlantic sturgeon.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks passage past the dam at Holyoke; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. The first dam on the Taunton River may block access to historical spawning habitat. Connectivity also may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent to which Atlantic sturgeon are affected by operations of dams in the New York Bight region is currently unknown. Atlantic sturgeon may also be impinged or entrained at power plants in the Hudson and Delaware Rivers, and may be adversely affected by the operation of the power plants, but the power plants have not been found to jeopardize their continued existence.

NYB DPS Atlantic sturgeon may also be affected by degraded water quality. Rivers in the New York Bight region, including the Hudson and Delaware, have been heavily polluted by industrial and sewer discharges. In general, water quality has improved in the Hudson and Delaware over the past several decades (Lichter *et al.* 2006; EPA 2008). While water quality has improved and most discharges are limited through regulations, it is likely that pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds, where developing eggs and larvae are particularly susceptible to exposure to contaminants.

Vessel strikes are known to occur in the Delaware River and may also be occurring in the Hudson and other New York Bight rivers. Twenty-nine mortalities believed to be the result of vessel strikes were documented in the Delaware River from 2004-2008, and at least 13 of these fish were large adults. Given the time of year in which the fish were observed (predominantly May through July, with two in August), it is likely that many of the adults were migrating through the river to the spawning grounds. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the NYB DPS.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman 1997; ASMFC TC 2007; Kahnle *et al.* 2007; Brown and Murphy 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the NYB DPS. As described in Section 4.2.4, we have estimated that there are a minimum of 33,210 NYB DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in the action area. We have determined that the NYB DPS is currently at risk of extinction due to: (1)

precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect population recovery.

4.2.4.3 Chesapeake Bay DPS of Atlantic sturgeon

The CB DPS includes the following: all anadromous Atlantic sturgeon that spawn or are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, Virginia. The marine range of Atlantic sturgeon from the CB DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the CB DPS and the adjacent portion of the marine range are shown in Figure 1. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT 2007). Based on the review by Oakley (2003), 100% of Atlantic sturgeon habitat is currently accessible in these rivers since most of the barriers to passage (i.e., dams) are located upriver of where spawning is expected to have historically occurred (ASSRT 2007). Spawning still occurs in the James River, and the presence of juvenile and adult sturgeon in the York River suggests that spawning may occur there as well (Musick *et al.* 1994; ASSRT 2007; Greene *et al*. 2009). However, conclusive evidence of current spawning is only available for the James River, where a recent study found evidence of Atlantic sturgeon spawning in the fall (Balazik *et al*. 2012). Atlantic sturgeon that are spawned elsewhere are known to use the Chesapeake Bay for other life functions, such as foraging and as juvenile nursery habitat (Vladykov and Greeley 1963; Wirgin *et al.* 2000; ASSRT 2007; Grunwald *et al.* 2008).

Age to maturity for CB DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is five to 19 years for Atlantic sturgeon originating from South Carolina rivers (Smith *et al.* 1982) and 11 to 21 years for Atlantic sturgeon originating from the Hudson River (Young *et al.* 1998). Therefore, age at maturity for Atlantic sturgeon of the CB DPS likely falls within these values.

Several threats play a role in shaping the current status of CB DPS Atlantic sturgeon. Historical records provide evidence of the large-scale commercial exploitation of Atlantic sturgeon from the James River and Chesapeake Bay in the 19th century (Hildebrand and Schroeder 1928; Vladykov and Greeley 1963; ASMFC 1998b; Secor 2002; Bushnoe *et al.* 2005; ASSRT 2007) as well as subsistence fishing and attempts at commercial fisheries as early as the 17th century (Secor 2002; Bushnoe *et al.* 2005; ASSRT 2007; Balazik *et al.* 2010). Habitat disturbance caused by in-river work, such as dredging for navigational purposes, is thought to have reduced available spawning habitat in the James River (Holton and Walsh 1995; Bushnoe *et al.* 2005; ASSRT 2007). At this time, we do not have information to quantify this loss of spawning habitat.

Decreased water quality also threatens Atlantic sturgeon of the CB DPS, especially since the Chesapeake Bay system is vulnerable to the effects of nutrient enrichment due to a relatively low tidal exchange and flushing rate, large surface-to-volume ratio, and strong stratification during the spring and summer months (Pyzik *et al.* 2004; ASMFC 1998a; ASSRT 2007; EPA 2008).

These conditions contribute to reductions in dissolved oxygen levels throughout the Bay. The availability of nursery habitat, in particular, may be limited given the recurrent hypoxia (low dissolved oxygen) conditions within the Bay (Niklitschek and Secor 2005, 2010). Heavy industrial development during the 20th century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery.

Although there have been improvements in the some areas of the Bay's health, the ecosystem remains in poor condition. The EPA gave the overall health of the Bay a grade of 45% based on goals for water quality, habitats, lower food web productivity, and fish and shellfish abundance (EPA CBP 2010). This was a 6% increase from 2008. According to the EPA, the modest gain in the health score was due to a large increase in the adult blue crab population, expansion of underwater grass beds growing in the Bay's shallows, and improvements in water clarity and bottom habitat health as highlighted below:

- 12% of the Bay and its tidal tributaries met CWA standards for dissolved oxygen between 2007 and 2009, a decrease of 5% from 2006 to 2008,
- 26% of the tidal waters met or exceeded guidelines for water clarity, a 12% increase from 2008,
- Underwater bay grasses covered 9,039 more acres of the Bay's shallow waters for a total of 85,899 acres, 46% of the Bay-wide goal,
- The health of the Bay's bottom dwelling species reached a record high of 56% of the goal, improving by approximately 15% Bay-wide, and
- The adult blue crab population increased to 223 million, its highest level since 1993.

At this time we do not have sufficient information to quantify the extent that degraded water quality effects habitat or individuals in the James River or throughout the Chesapeake Bay.

Vessel strikes have been observed in the James River (ASSRT 2007). Eleven Atlantic sturgeon were reported to have been struck by vessels from 2005-2007. Several of these were mature individuals. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the CB DPS.

In the marine and coastal range of the CB DPS from Canada to Florida, fisheries bycatch in federally and state-managed fisheries poses a threat to the DPS, reducing survivorship of subadults and adults and potentially causing an overall reduction in the spawning population (Stein *et al.* 2004b; ASMFC TC 2007; ASSRT 2007).

Summary of the Chesapeake Bay DPS

Spawning for the CB DPS is known to occur in only the James and Pamunkey Rivers. Spawning may be occurring in other rivers, such as the York, Rappahannock, Potomac, Nanticoke, and Susquehanna, but has not been confirmed for any of those. There are anecdotal reports of increased sightings and captures of Atlantic sturgeon in the James River. However, this information has not been comprehensive enough to develop a population estimate for the James River or to provide sufficient evidence to confirm increased abundance. Some of the impact from the threats that facilitated the decline of the CB DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the CWA. As described in Section 4.2.4, we have estimated that there are a minimum of 9,489 CB DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in the action area.

Areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in U.S. state and federally-managed fisheries, Canadian fisheries, and vessel strikes remain significant threats to the CB DPS of Atlantic sturgeon. Of the 35% of Atlantic sturgeon incidentally caught in the Bay of Fundy, about 1% were CB DPS fish (Wirgin *et al.* 2012). Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman 1997; ASMFC TC 2007; Kahnle *et al.* 2007). The CB DPS is currently at risk of extinction given (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect the potential for population recovery.

4.2.4.4 Carolina DPS of Atlantic sturgeon

The Carolina DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. The marine range of Atlantic sturgeon from the Carolina DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the Carolina DPS and the adjacent portion of the marine range are shown in Figure 1. Sturgeon are commonly captured 40 miles offshore (Dewayne Fox, Delaware State University, pers. comm.). Records providing fishery bycatch data by depth show the vast majority of Atlantic sturgeon bycatch via gillnets is observed in waters less than 50 meters deep (Stein *et al*. 2004b, ASMFC TC 2007), but Atlantic sturgeon are recorded as bycatch out to 500 fathoms.

Rivers known to have current spawning populations within the range of the Carolina DPS include the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, and Pee Dee Rivers. We determined spawning was occurring if YOY were observed or mature adults were present in freshwater portions of a system (Table 9). However, in some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. There may also be spawning populations in the Neuse, Santee, and Cooper Rivers, though it is uncertain. Historically, both the Sampit and Ashley Rivers were documented to have spawning populations at one time. However, the spawning population in the Sampit River is believed to be extirpated, and the current status of the spawning population in the Ashley River is unknown. Both rivers may be used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. Fish from the Carolina DPS likely use other river systems than those listed here for their specific life functions.

Historical landings data indicate that between 7,000 and 10,500 adult female Atlantic sturgeon were present in North Carolina prior to 1890 (Armstrong and Hightower 2002; Secor 2002). Secor (2002) estimates that 8,000 adult females were present in South Carolina during that same

Table 9. Major rivers, tributaries, and sounds within the range of the Carolina DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.

River/Estuary	**Spawning Population**	**Data**
Roanoke River, VA/NC; Albemarle Sound, NC	Yes	collection of 15 YOY (1997-1998); single YOY (2005)
Tar-Pamlico River, NC; Pamlico Sound	Yes	one YOY (2005)
Neuse River, NC; Pamlico Sound	Unknown	
Cape Fear River, NC	Yes	upstream migration of adults in the fall, carcass of a ripe female upstream in mid-September (2006)
Waccamaw River, SC; Winyah Bay	Yes	age-1, potentially YOY (1980s)
Pee Dee River, SC; Winyah Bay	Yes	running ripe male in Great Pee Dee River (2003)
Sampit, SC; Winyah Bay	Extirpated	
Santee River, SC	Unknown	
Cooper River, SC	Unknown	
Ashley River, SC	Unknown	

time frame. Prior reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the Carolina DPS. Currently, the Atlantic sturgeon spawning population in at least one river system within the Carolina DPS has been extirpated, with potential extirpation in an additional system. The abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, are estimated to be less than 3% of what they were historically (ASSRT 2007). As described in Section 4.2.4, we have estimated that there are a minimum of 2,711 Carolina DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in the action area.

Threats

The Carolina DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overutilization (i.e., being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dams, dredging, and degraded water quality is contributing to the status of the Carolina DPS. Dams have curtailed Atlantic sturgeon spawning and juvenile developmental habitat by blocking more than 60% of the historical sturgeon habitat upstream of the dams in the Cape Fear and Santee-Cooper River systems. Water quality (velocity, temperature, and dissolved oxygen) downstream of these dams, as well as on the Roanoke River, has been reduced, which modifies and curtails the extent of spawning and nursery habitat for the Carolina DPS. Dredging in spawning and nursery grounds modifies the quality of the habitat and is further curtailing the extent of available habitat in the Cape Fear and Cooper Rivers, where Atlantic sturgeon habitat has already been modified and curtailed by the presence of dams. Reductions in water quality from terrestrial activities have modified habitat used by the Carolina DPS. In the Pamlico and Neuse systems, nutrient-loading and seasonal anoxia are occurring, associated in part with concentrated animal feeding operations (CAFOs). Heavy industrial development and CAFOs have also degraded water quality in the Cape Fear River. Water quality in the Waccamaw and Pee Dee Rivers has been affected by industrialization and riverine sediment samples contain high levels of various toxins, including dioxins. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the Carolina DPS. Twenty interbasin water transfers in existence prior to 1993, averaging 66.5 million gallons per day (mgd), were authorized at their maximum levels without being subjected to an evaluation for certification by the North Carolina Department of Environmental and Natural Resources and other resource agencies. Since the 1993 legislation requiring certificates for transfers took effect, almost 170 mgd of interbasin water withdrawals have been authorized, with an additional 60 mgd pending certification. The removal of large amounts of water from the system will alter flows, temperature, and dissolved oxygen. Existing water allocation issues will likely be compounded by population growth and potentially climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower dissolved oxygen, all of which are current stressors to the Carolina DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast in the mid- to late 19th century, from which they have never rebounded. Continued bycatch of Atlantic sturgeon in commercial fisheries is an ongoing impact to the Carolina DPS. More robust fishery independent data on bycatch are available for the Northeast and Mid-Atlantic than in the Southeast where high levels of bycatch underreporting are suspected.

Though there are statutory and regulatory regulations that authorize reducing the impact of dams on riverine and anadromous species, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Water quality continues to be a problem in the Carolina DPS, even with existing controls on some pollution sources. Current regulatory regimes are not effective in controlling water allocation issues (e.g., no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution, etc.).

The recovery of Atlantic sturgeon along the Atlantic Coast, especially in areas where habitat is limited and water quality is severely degraded, will require improvements in the following areas: (1) elimination of barriers to spawning habitat either through dam removal, breaching, or installation of successful fish passage facilities; (2) operation of water control structures to provide appropriate flows, especially during spawning season; (3) imposition of dredging restrictions including seasonal moratoriums and avoidance of spawning/nursery habitat; and (4) mitigation of water quality parameters that are restricting sturgeon use of a river (i.e., dissolved oxygen). Additional data regarding sturgeon use of riverine and estuarine environments are needed.

The concept of a viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon, and the low population numbers of every river population in the Carolina DPS put them in danger of extinction throughout their range; none of the populations are large or stable enough to provide with any level of certainty for the continued existence of Atlantic sturgeon in this part of its range. Although the largest impact that caused the precipitous decline of the species has been curtailed (directed fishing), the population sizes within the Carolina DPS have remained relatively constant at greatly reduced levels (approximately 3% of historical population sizes) for 100 years. Small numbers of individuals resulting from drastic reductions in populations, such as that which occurred due to the commercial fishery, can remove the buffer against natural demographic and environmental variability provided by large populations (Berry 1971; Soulé 1980; Shaffer 1981). Recovery of depleted populations is an inherently slow process for late-maturing species such as Atlantic sturgeon, and they continue to face a variety of other threats that contribute to their risk of extinction. Their late age at maturity provides more opportunities for individual Atlantic sturgeon to be removed from the population before reproducing. While a long life-span also allows multiple opportunities to contribute to future generations, it also increases the timeframe over which exposure to the multitude of threats facing the Carolina DPS can occur. The viability of the Carolina DPS depends on having multiple self-sustaining riverine spawning populations and maintaining suitable habitat to support the various life functions (spawning, feeding, growth) of Atlantic sturgeon populations.

Summary of the Status of the Carolina DPS of Atlantic Sturgeon
Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon. Their late age at maturity provides more opportunities for individuals to be removed from the population before reproducing. While a long life-span also allows multiple opportunities to contribute to future generations, this is hampered within the Carolina DPS by habitat alteration and bycatch. This DPS was severely depleted by past directed commercial fishing, and faces ongoing impacts and threats from habitat alteration or inaccessibility, bycatch, and the inadequacy of existing regulatory mechanisms to address and reduce habitat alterations and bycatch that have prevented river populations from rebounding and will prevent their recovery.

The presence of dams has resulted in the loss of more than 60% of the historical sturgeon habitat on the Cape Fear River and in the Santee-Cooper system. Dams are contributing to the status of the Carolina DPS by curtailing the extent of available spawning habitat and further modifying the remaining habitat downstream by affecting water quality parameters (such as depth, temperature, velocity, and dissolved oxygen) that are important to sturgeon. Dredging is also contributing to the status of the Carolina DPS by modifying Atlantic sturgeon spawning and nursery habitat. Habitat modifications through reductions in water quality are contributing to the status of the Carolina DPS due to nutrient-loading, seasonal anoxia, and contaminated sediments. Interbasin water transfers and climate change threaten to exacerbate existing water quality issues. Bycatch is also a current threat to the Carolina DPS that is contributing to its status. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may use multiple river systems for nursery and foraging habitat in addition to their natal spawning river, they are subject to being caught in multiple fisheries throughout their range. In addition to direct mortality, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins). This may result in either reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality. While many of the threats to the Carolina DPS have been ameliorated or reduced due to existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch and habitat alterations are currently not being addressed through existing mechanisms. Further, despite NMFS's authority under the Federal Power Act to prescribe fish passage and existing controls on some pollution sources, access to habitat and improved water quality continues to be a problem. The inadequacy of regulatory mechanisms to control bycatch and habitat alterations is contributing to the status of the Carolina DPS.

4.2.4.5 South Atlantic DPS of Atlantic sturgeon

The SA DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the Ashepoo, Combahee, and Edisto Rivers (ACE) Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. The marine range of Atlantic sturgeon from the SA DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the SA DPS and the adjacent portion of the marine range are shown in Figure 1. Sturgeon are commonly captured 40 miles offshore (Dewayne Fox, Delaware State University, pers. comm.). Records providing fishery bycatch data by depth show the vast majority of Atlantic sturgeon bycatch via gillnets is observed in waters less than 50 meters deep (Stein *et al.* 2004b, ASMFC TC 2007), but Atlantic sturgeon are recorded as bycatch out to 500 fathoms (900 meters).

Rivers known to have current spawning populations within the range of the South Atlantic DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, and Satilla Rivers. We determined spawning was occurring if YOY were observed, or mature adults were present, in freshwater portions of a system (Table 10). However, in some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. Historically, both the Broad-Coosawatchie and St. Marys Rivers were documented to have spawning populations at one time; there is also evidence that spawning may have occurred in the St. Johns River or one of its tributaries. However, the spawning population in the St. Marys River, as well as any historical spawning population present in the St. Johns, is believed to be extirpated, and the status of the spawning population in the Broad-Coosawatchie is unknown. Both the St. Marys and St. Johns Rivers are used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. The use of the Broad-Coosawatchie by sturgeon from other spawning populations is unknown at this time. The presence of historical and current spawning populations in the Ashepoo River has not been documented; however, this river may currently be used for nursery habitat by young Atlantic sturgeon originating from other spawning populations. Fish from the SA DPS likely use other river systems than those listed here for their specific life functions.

Secor (2002) estimates that 8,000 adult females were present in South Carolina before the collapse of the fishery in 1890. However, because fish from South Carolina are included in both the Carolina and SA DPSs, it is likely that some of the historical 8,000 fish would be attributed

Table 10. Major rivers, tributaries, and sounds within the range of the SA DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.

River/Estuary	Spawning Population	Data
ACE (Ashepoo, Combahee, and Edisto Rivers) Basin, SC; St. Helena Sound	Yes	1,331 YOY (1994-2001); gravid female and running ripe male in the Edisto (1997); 39 spawning adults (1998)
Broad-Coosawhatchie Rivers, SC; Port Royal Sound	Unknown	
Savannah River, SC/GA	Yes	22 YOY (1999-2006); running ripe male (1997)
Ogeechee River, GA	Yes	age-1 captures, but high inter-annual variability (1991-1998); 17 YOY (2003); 9 YOY (2004)
Altamaha River, GA	Yes	74 captured/308 estimated spawning adults (2004); 139 captured/378 estimated spawning adults (2005)
Satilla River, GA	Yes	4 YOY and spawning adults (1995-1996)
St. Marys River, GA/FL	Extirpated	
St. Johns River, FL	Extirpated	

to both the Carolina DPS and SA DPS. The sturgeon fishery had been the third largest fishery in Georgia. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the South Atlantic DPS. Currently, the Atlantic sturgeon population in at least two river systems within the SA DPS has been extirpated. As described in Section 4.2.4, we have estimated that there are a minimum of 13,555 SA DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in the action area.

Threats

The SA DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overuse (i.e., being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dredging and degraded water quality is contributing to the status of the SA DPS. Dredging is a present threat to the SA DPS and is contributing to its status by modifying the quality and availability of Atlantic sturgeon habitat. Maintenance dredging is currently modifying Atlantic sturgeon nursery habitat in the Savannah River and modeling indicates that the proposed deepening of the navigation channel will result in reduced dissolved oxygen and upriver movement of the salt wedge, curtailing spawning habitat. Dredging is also modifying nursery and foraging habitat in the St. Johns Rivers. Reductions in water quality from terrestrial activities have modified habitat used by the SA DPS. Low dissolved oxygen is modifying sturgeon habitat in the Savannah due to dredging, and non-point source inputs are causing low dissolved oxygen in the Ogeechee River and in the St. Marys River, which completely eliminates juvenile nursery habitat in summer. Low dissolved oxygen has also been observed in the St. Johns River in the summer. Sturgeon are more sensitive to low dissolved oxygen and the negative (metabolic, growth, and feeding) effects caused by it increase when water temperatures are concurrently high, as they are within the range of the SA DPS. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the SA DPS. Large withdrawals of over 240 million gallons per day mgd of water occur in the Savannah River for power generation and municipal uses. However, permits for users withdrawing less than 100,000 gallons per day (gpd) are not required to get permits, so actual water withdrawals from the Savannah and other rivers within the range of the SA DPS are unknown, but likely much higher. The removal of large amounts of water from the system will alter flows, temperature, and dissolved oxygen. Water shortages and "water wars" are already occurring in the rivers occupied by the SA DPS and will likely be compounded in the future by population growth and, potentially, by climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower dissolved oxygen, all of which are current stressors to the SA DPS.

The directed Atlantic sturgeon fishery caused initial severe declines in southeast Atlantic sturgeon populations. Although the directed fishery is closed, bycatch in other commercial fisheries continues to impact the SA DPS. Statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species such as Atlantic sturgeon, but these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the SA DPS, even with existing controls on some pollution sources. Current regulatory regimes are not effective in controlling water allocation issues (e.g., no permit requirements for water withdrawals under 100,000 gpd in Georgia, no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution.)

The recovery of Atlantic sturgeon along the Atlantic coast, especially in areas where habitat is limited and water quality is severely degraded, will require improvements in the following areas: (1) elimination of barriers to spawning habitat either through dam removal, breaching, or installation of successful fish passage facilities; (2) operation of water control structures to provide appropriate flows, especially during spawning season; (3) imposition of dredging restrictions including seasonal moratoriums and avoidance of spawning/nursery habitat; and (4) mitigation of water quality parameters that are restricting sturgeon use of a river (i.e., dissolved oxygen). Additional data regarding sturgeon use of riverine and estuarine environments is needed.

Summary of the Status of the South Atlantic DPS of Atlantic Sturgeon

As described in Section 4.2.4, we have estimated that there are a minimum of 13,555 SA DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in the action area. The DPS's freshwater range occurs in the watersheds (including all rivers and tributaries) of the ACE Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon. Their late age at maturity provides more opportunities for individuals to be removed from the population before reproducing. While a long life-span also allows multiple opportunities to contribute to future generations, this is hampered within the SA DPS by habitat alteration, bycatch, and from the inadequacy of existing regulatory mechanisms to address and reduce habitat alterations and bycatch.

Dredging is contributing to the status of the SA DPS by modifying spawning, nursery, and foraging habitat. Habitat modifications through reductions in water quality and dissolved oxygen are also contributing to the status of the SA DPS, particularly during times of high water temperatures, which increase the detrimental effects on Atlantic sturgeon habitat. Interbasin water transfers and climate change threaten to exacerbate existing water quality issues. Bycatch also contributes to the SA DPS's status. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may use multiple river systems for nursery and foraging habitat in addition to their natal spawning river, they are subject to being caught in multiple fisheries throughout their range. In addition to direct mortality, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality. While many of the threats to the SA DPS have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch and habitat alteration are currently not being addressed through existing mechanisms. Further, access to habitat and good water quality continues to be a problem even with NMFS's authority under the Federal Power Act to prescribe fish passage and existing controls on some pollution sources. There is a lack of regulation for some large water withdrawals, which threatens sturgeon habitat. Current regulatory regimes do not require a permit for water withdrawals under 100,000 gpd in Georgia and there are no restrictions on interbasin water transfers in South Carolina. Data required to evaluate water allocation issues are either very weak, in terms of determining the precise amounts of water currently being used, or non-existent, in terms of our knowledge of water supplies available for use under historical hydrologic conditions in the region. Existing water allocation issues will likely be compounded by population growth, drought, and, potentially, climate change. The inadequacy of regulatory mechanisms to control bycatch and habitat alterations is contributing to the status of the SA DPS.

4.2.5 Status of the Gulf of Maine DPS of Atlantic Salmon

Species Description
The Atlantic salmon is an anadromous fish species that spends most of its adult life in the ocean but returns to freshwater to reproduce. The Atlantic salmon is native to the North Atlantic Ocean, from the Arctic Circle to Portugal in the eastern Atlantic, from Iceland and southern Greenland, and from the Ungava region of northern Quebec south to the Connecticut River (Scott and Crossman 1973). In the U.S., Atlantic salmon historically ranged from Maine south to Long Island Sound. However, the Central New England DPS and Long Island Sound DPS have both been extirpated (65 FR 69459; November 17, 2000).

The Gulf of Maine DPS of anadromous Atlantic salmon was initially listed jointly by the USFWS and NMFS as an endangered species on November 17, 2000 (65 FR 69459). In 2009 the

Services finalized an expanded listing of Atlantic salmon as an endangered species (74 FR 29344; June 19, 2009). The decision to expand the range of the Gulf of Maine DPS was largely based on the results of a Status Review (Fay *et al.* 2006) completed by a Biological Review Team consisting of Federal and State agencies and Tribal interests. Fay *et al.* (2006) conclude that the DPS delineation in the 2000 listing designation was largely appropriate, except in the case of large rivers that were partially or wholly excluded in the 2000 listing determination. Fay *et al.* (2006) conclude that the salmon currently inhabiting the larger rivers (Androscoggin, Kennebec, and Penobscot) are genetically similar to the rivers included in the Gulf of Maine DPS as listed in 2000, have similar life history characteristics, and occur in the same zoogeographic region. Further, the salmon populations inhabiting the large and small rivers from the Androscoggin River northward to the Dennys River differ genetically and in important life history characteristics from Atlantic salmon in adjacent portions of Canada (Spidle *et al.* 2003, Fay *et al.* 2006). Thus, Fay *et al.* (2006) conclude that this group of populations (a "distinct population segment") met both the discreteness and significance criteria of the Services' DPS Policy (61 FR 4722; February 7, 1996) and, therefore, recommend the geographic range included in the new expanded Gulf of Maine DPS.

The current Gulf of Maine DPS includes 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. The following impassable falls delimit the upstream extent of the freshwater range: Rumford Falls in the town of Rumford on the Androscoggin River; Snow Falls in the town of West Paris on the Little Androscoggin River; Grand Falls in Township 3 Range 4 BKP WKR on the Dead River in the Kennebec Basin; the un-named falls (impounded by Indian Pond Dam) immediately above the Kennebec River Gorge in the town of Indian Stream Township on the Kennebec River; Big Niagara Falls on Nesowadnehunk Stream in Township 3 Range 10 WELS in the Penobscot Basin; Grand Pitch on Webster Brook in Trout Brook Township in the Penobscot Basin; and Grand Falls on the Passadumkeag River in Grand Falls Township in the Penobscot Basin. The marine range of the Gulf of Maine DPS extends from the Gulf of Maine, throughout the Northwest Atlantic Ocean, to the coast of Greenland.

Included in the Gulf of Maine DPS are all associated conservation hatchery populations used to supplement these natural populations; currently, such conservation hatchery populations are maintained at Green Lake National Fish Hatchery (GLNFH) and Craig Brook National Fish Hatchery (CBNFH), both operated by the USFWS. Excluded from the Gulf of Maine DPS are landlocked Atlantic salmon and those salmon raised in commercial hatcheries for the aquaculture industry (74 FR 29344; June 19, 2009).

Atlantic salmon have a complex life history that includes territorial rearing in rivers to extensive feeding migrations on the high seas. During their life cycle, Atlantic salmon go through several distinct phases that are identified by specific changes in behavior, physiology, morphology, and habitat requirements.

Adult Atlantic salmon return to rivers from the sea and migrate to their natal stream to spawn; a small percentage (1-2%) of returning adults in Maine will stray to a new river. Adults ascend the rivers within the Gulf of Maine DPS beginning in the spring. The ascent of adult salmon continues into the fall. Although spawning does not occur until late fall, the majority of Atlantic salmon in Maine enter freshwater between May and mid-July (Meister 1958; Baum 1997). Early migration is an adaptive trait that ensures adults have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Salmon that return in early spring spend nearly five months in the river before spawning, often seeking cool water refuge (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months.

In the fall, female Atlantic salmon select sites for spawning in rivers. Spawning sites are positioned within flowing water, particularly where upwelling of groundwater occurs, allowing for percolation of water through the gravel (Danie *et al.* 1984). These sites are most often positioned at the head of a riffle (Beland *et al.* 1982); the tail of a pool; or the upstream edge of a gravel bar where water depth is decreasing, water velocity is increasing (White 1942; McLaughlin and Knight 1987), and hydraulic head allows for permeation of water through the redd (a gravel depression where eggs are deposited). Female salmon use their caudal fin to scour or dig redds. The digging behavior also serves to clean the substrate of fine sediments that can embed the cobble and gravel substrates needed for spawning and consequently reduce egg survival (Gibson 1993). One or more males fertilize the eggs that the female deposits in the redd (Jordan and Beland 1981). The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel.

A single female may create several redds before depositing all of her eggs. Female anadromous Atlantic salmon produce a total of 1,500 to 1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs per two sea-winter (2SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum and Meister 1971). After spawning, Atlantic salmon may either return to sea immediately or remain in fresh water until the following spring before returning to the sea (Fay *et al.* 2006). From 1996 to 2011, approximately 1.3% of the "naturally-reared" adults (fish originating from natural spawning or hatchery fry) in the Penobscot River were repeat spawners (USASAC 2012).

Embryos develop in redds for a period of 175 to 195 days, hatching in late March or April (Danie *et al.* 1984). Newly hatched salmon, referred to as larval fry, alevin, or sac fry, remain in the redd for approximately six weeks after hatching and are nourished by their yolk sac (Gustafson-Greenwood and Moring 1991). Survival from the egg to fry stage in Maine is estimated to range from 15-35% (Jordan and Beland 1981). Survival rates of eggs and larvae are a function of stream gradient, overwinter temperatures, interstitial flow, predation, disease, and competition (Bley and Moring 1988). Once larval fry emerge from the gravel and begin active feeding, they are referred to as fry. The majority of fry (>95%) emerge from redds at night (Gustafson-Marjanen and Dowse 1983).

When fry reach approximately four centimeters in length, the young salmon are termed parr (Danie *et al.* 1984). Parr have eight to eleven pigmented vertical bands on their sides that are believed to serve as camouflage (Baum 1997). A territorial behavior, first apparent during the fry stage, grows more pronounced during the parr stage, as the parr actively defend territories (Allen 1940, Kalleberg 1958, Danie *et al.* 1984). Most parr remain in the river for two to three years before undergoing smoltification, the process in which parr go through physiological changes in order to transition from a freshwater environment to a saltwater marine environment. Some male parr may not go through smoltification and will become sexually mature and participate in spawning with sea-run adult females. These males are referred to as "precocious parr." First year parr are often characterized as being small parr or 0+ parr (four to seven centimeters long), whereas second and third year parr are characterized as large parr (greater than seven cm long) (Haines 1992). Parr growth is a function of water temperature (Elliott 1991); parr density (Randall 1982); photoperiod (Lundqvist 1980); interaction with other fish, birds, and mammals (Bjornn and Reiser 1991); and food supply (Swansburg *et al.* 2002). Parr movement may be quite limited in the winter (Cunjak 1988, Heggenes 1990); however, movement in the winter does occur (Hiscock *et al.* 2002) and is often necessary, as ice formation reduces total habitat availability (Whalen *et al.* 1999). Parr have been documented using riverine, lake, and estuarine habitats; incorporating opportunistic and active feeding strategies; defending territories from competitors including other parr; and working together in small schools to actively pursue prey (Gibson 1993, Marschall *et al.*1998, Pepper 1976, Pepper *et al.* 1984, Hutchings 1986, Erkinaro *et al.* 1998, Halvorsen and Svenning 2000, O'Connell and Ash 1993, Erkinaro *et al.* 1995, Dempson *et al.* 1996, Klemetsen *et al.* 2003).

In a parr's second or third spring (age 1 or age 2, respectively), when it has grown to 12.5 to 15 cm in length, a series of physiological, morphological, and behavioral changes occur (Schaffer and Elson 1975). This process, called "smoltification," prepares the parr for migration to the ocean and life in salt water. In Maine, the vast majority of naturally reared parr remain in fresh water for two years (90% or more) with the balance remaining for either one or three years (USASAC 2005). In order for parr to undergo smoltification, they must reach a critical size of ten centimeters total length at the end of the previous growing season (Hoar 1988). During the smoltification process, parr markings fade and the body becomes streamlined and silvery with a pronounced fork in the tail. Naturally reared smolts in Maine range in size from 13 to 17 centimeters, and most smolts enter the sea during May to begin their first ocean migration (USASAC 2004). During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and various predator assemblages. The physiological changes that occur during smoltification prepare the fish for the dramatic change in osmoregulatory needs that come with the transition from a fresh to a salt water habitat (Ruggles 1980, Bley 1987, McCormick and Saunders 1987, McCormick *et al.* 1998). The transition of smolts into seawater is usually gradual as they pass through a zone of fresh and saltwater mixing that typically occurs in a river's estuary. Given that smolts undergo smoltification while they are still in the river, they are pre-adapted to make a direct entry into seawater with minimal acclimation (McCormick *et al.* 1998). This pre-adaptation to seawater is necessary under some circumstances where there is very little transition zone between freshwater and the marine environment.

The spring migration of post-smolts out of the coastal environment is generally rapid, within several tidal cycles, and follows a direct route (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004). Post-smolts generally travel out of coastal systems on the ebb tide and may be delayed by flood tides (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004, Lacroix and Knox 2005). Lacroix and McCurdy (1996), however, found that post-smolts exhibit active, directed swimming in areas with strong tidal currents. Studies in the Bay of Fundy and Passamaquoddy Bay suggest that post-smolts aggregate together and move near the coast in “common corridors” and that post-smolt movement is closely related to surface currents in the bay (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004). European post-smolts tend to use the open ocean for a nursery zone, while North American post-smolts appear to have a more near-shore distribution (Friedland *et al.* 2003). Post-smolt distribution may reflect water temperatures (Reddin and Shearer 1987) or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts live mainly on the surface of the water column and form shoals, possibly of fish from the same river (Shelton *et al.* 1997).

During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56^{o}N and 58^{o}N (Reddin 1985, Reddin and Short 1991, Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish or MSW) and also includes immature salmon from both North American and European stocks (Reddin 1988, Reddin *et al.* 1988). The first winter at sea regulates annual recruitment, and the distribution of winter habitat in the Labrador Sea and Denmark Strait may be critical for North American populations (Friedland *et al.* 1993). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985, Dutil and Coutu 1988, Ritter 1989, Reddin and Friedland 1993, Friedland *et al.* 1999).

Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Reddin and Friedland (1993) found immature adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

Status and Trends of Atlantic Salmon in the Gulf of Maine DPS

The abundance of Atlantic salmon within the range of the Gulf of Maine DPS has been generally declining since the 1800s (Fay *et al.* 2006). Data sets tracking adult abundance are not available throughout this entire time period; however, a comprehensive time series of adult returns to the Gulf of Maine DPS dating back to 1967 exists (Fay *et al.* 2006, USASAC 2001-2012) (Figure 3). It is important to note that contemporary abundance levels of Atlantic salmon within the Gulf of Maine DPS are several orders of magnitude lower than historical abundance estimates. For example, Foster and Atkins (1869) estimated that roughly 100,000 adult salmon returned to the Penobscot River alone before the river was dammed, whereas contemporary estimates of abundance for the entire Gulf of Maine DPS have rarely exceeded 5,000 individuals in any given year since 1967 (Fay *et al.* 2006, USASAC 2010).

Contemporary abundance estimates are informative in considering the conservation status of the Gulf of Maine DPS today. After a period of population growth in the 1980s, adult returns of salmon in the Gulf of Maine DPS declined steadily between the early 1990s and the early 2000s and have trended towards stable to increasing from the period between 2000 and 2011. The population growth observed in the 1980s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH that was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the Gulf of Maine DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed throughout the 1990s and 2000s.

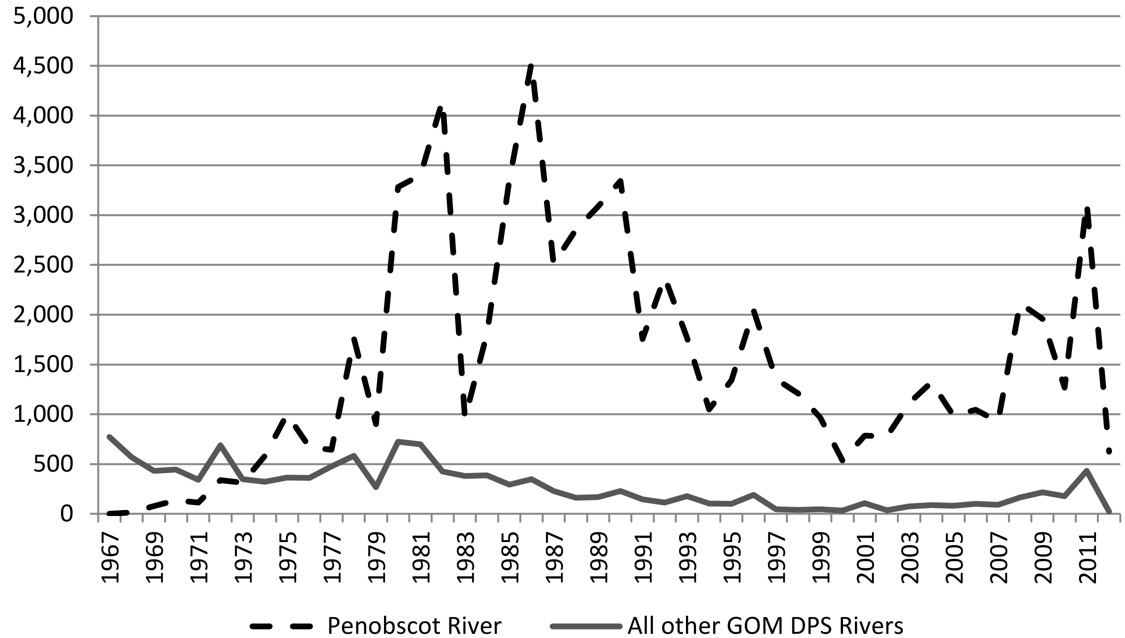


Figure 3. Adult returns to the Gulf of Maine DPS Rivers between 1967 and 2012 (Fay *et al.* 2006; USASAC 2001-2013).

Adult returns to the Gulf of Maine DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Further, the majority of all adults in the Gulf of Maine DPS return to a single river, the Penobscot, which accounted for 91% of all adult returns to the Gulf of Maine DPS between 2000 and 2011. Of the 3,125 adult returns to the Penobscot in 2011, the majority are the result of smolt stocking; and only a small portion were naturally-reared. The term naturally-reared includes fish originating from both natural spawning and from stocked hatchery fry (USASAC 2012). Hatchery fry are included as naturally-reared because hatchery fry are not marked and, therefore, cannot be distinguished from fish produced through natural spawning. Because of the extensive amount of fry stocking that takes place in an effort to recover the Gulf of Maine DPS, it is possible that a substantial number of fish counted as naturally-reared were actually hatchery fry.

Low abundances of both hatchery-origin and naturally-reared adult salmon returns to Maine demonstrate continued poor marine survival. Declines in hatchery-origin adult returns are less sharp because of the ongoing effects of consistent hatchery supplementation of smolts. In the Gulf of Maine DPS, nearly all of the hatchery-reared smolts are released into the Penobscot River - 560,000 smolts in 2009 (USASAC 2010). In contrast, the number of returning naturally-reared adults continues at low levels due to poor marine survival.

In conclusion, the trend in abundance of Atlantic salmon in the Gulf of Maine DPS 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 6% 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 salmon and as yet has not been able to increase the naturally reared component of the Gulf of Maine DPS. Continued reliance on the conservation hatchery program could prevent extinction but will not accomplish recovery of the Gulf of Maine DPS, which must be accomplished through increases in naturally reared salmon.

Threats to the Species

The recovery plan for the previously designated Gulf of Maine DPS (NMFS and USFWS 2005), the latest status review (Fay *et al.* 2006), and the 2009 listing rule all provide a comprehensive assessment of the many factors, including both threats and conservation actions, that are currently affecting the status and recovery of listed Atlantic salmon. The USFWS and NMFS have just written a new draft recovery plan that includes the current, expanded Gulf of Maine DPS and its designated critical habitat. The new draft recovery plan provides the most up to date list of significant threats affecting the Gulf of Maine DPS. These are the following:

- Dams
- Inadequacy of existing regulatory mechanisms for dams
- Continued low marine survival rates for U.S. stocks of Atlantic salmon
- Lack of access to spawning and rearing habitat due to dams and road-stream crossings

In addition to these significant threats there are a number of lesser stressors. These are the following:

- Degraded water quality
- Aquaculture practices, which pose ecological and genetic risks
- Climate change
- Depleted diadromous fish communities
- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon
- Poaching of adults in DPS rivers
- Conservation hatchery program (potential for artificial selection/domestication)
- Sedimentation of spawning and rearing habitat
- Water extraction

Fay *et al.* (2006) examined each of the five statutory ESA listing factors and determined that each of the five listing factors is at least partly responsible for the present low abundance of the Gulf of Maine DPS. The information presented in Fay *et al.* (2006) is reflected in and supplemented by the final listing rule for the Gulf of Maine DPS (74 FR 29344; June 19, 2009). The following gives a brief overview of the five listing factors as related to the Gulf of Maine DPS.

a. **Present or threatened destruction, modification, or curtailment of its habitat or range –** Historically and, to a lesser extent currently, dams have adversely impacted Atlantic salmon by obstructing fish passage and degrading riverine habitat. Dams are considered to be one of the primary causes of both historic declines and the contemporary low abundance of the Gulf of Maine DPS. Land use practices, including forestry and agriculture, have reduced habitat complexity (e.g., removal of large woody debris from rivers) and habitat connectivity (e.g., poorly designed road crossings) for Atlantic salmon. Water withdrawals, elevated sediment levels, and acid rain also degrade Atlantic salmon habitat.

b. **Overutilization for commercial, recreational, scientific, or educational purposes** – While most directed commercial fisheries for Atlantic salmon have ceased, the impacts from past fisheries are still important in explaining the present low abundance of the Gulf of Maine DPS. Both poaching and by-catch in recreational and commercial fisheries for other species remain of concern, given critically low numbers of salmon.

c. **Predation and disease –** Natural predator-prey relationships in aquatic ecosystems in the Gulf of Maine DPS have been substantially altered by introduction of non-native fishes (e.g., chain pickerel, smallmouth bass, and northern pike), declines of other native diadromous fishes, and alteration of habitat by impounding free-flowing rivers and removing instream structure (such as removal of boulders and woody debris during the log-driving era). The threat of predation on the Gulf of Maine DPS is noteworthy because of the imbalance between the very low numbers of returning adults and the recent increase in populations of some native predators (e.g., double-crested cormorant), as well as non-native predators. Atlantic salmon are susceptible to a number of diseases and parasites, but mortality is difficult to assess in the wild and therefore is primarily documented at conservation hatcheries, fish culture facilities and commercial aquaculture facilities.

d. **Inadequacy of existing regulatory mechanisms –** The ineffectiveness of current federal and state regulations at requiring fish passage and minimizing or mitigating the aquatic habitat impacts of dams is a significant threat to the Gulf of Maine DPS today. Furthermore, most dams in the Gulf of Maine DPS do not require state or federal permits. Although the State of Maine has made substantial progress in regulating water withdrawals for agricultural use, threats still remain within the Gulf of Maine DPS, including those from the effects of irrigation wells on salmon streams.

e. **Other natural or manmade factors –** Poor marine survival rates of Atlantic salmon are a significant threat, although the causes of these decreases are unknown. The role of ecosystem function among the freshwater, estuarine, and marine components of the Atlantic salmon's life history, including the relationship of other diadromous fish species in Maine (e.g., American shad, alewife, sea lamprey), is receiving increased scrutiny in its contribution to the current status of the Gulf of Maine DPS and its role in recovery of the Atlantic salmon. While current state and federal regulations pertaining to finfish aquaculture have reduced the risks to the Gulf of Maine DPS (including eliminating the use of non-North American Atlantic salmon and improving containment protocols), risks from the spread of diseases or parasites and direct genetic effects from farmed salmon escapees interbreeding with wild salmon still exist.

Summary of Information on the Gulf of Maine DPS of Atlantic Salmon in the Action Area
Adult returns for the Gulf of Maine DPS remain well below conservation spawning escapement (CSE). For all Gulf of Maine DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below CSE levels required to sustain themselves (Fay *et al.* 2006), which is further indication of their poor population status. The abundance of Atlantic salmon in the Gulf of Maine DPS 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 6% over the last ten years) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the Gulf of Maine DPS.

A number of activities within the Gulf of Maine DPS will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities (such as alternative energy development), mining, dams, dredging, and aquaculture. Dams, along with degraded substrate and cover, water quality, water temperature, and biological communities, have reduced the quality and quantity of habitat available to Atlantic salmon populations within the Gulf of Maine DPS.

Summary of Factors Affecting Recovery of Atlantic Salmon
There are a wide variety of factors that have and continue to affect the current status of the Gulf of Maine DPS and its critical habitat. The potential interactions among these factors are not well understood, nor are the reasons for the seemingly poor response of salmon populations to the many ongoing conservation efforts for this species.

Review of Threats

<u>Dams</u>
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 entire 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, which have been replaced by lacustrine communities following construction of a dam. Anadromous Atlantic salmon inhabiting the Gulf of Maine 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.

The Gulf of Maine from Cape Cod, Massachusetts to the St. Croix River in Eastern Maine contains 4,867 dams within the U.S., 782 of which are in Maine (GMCME 2010)[9]. Non-FERC regulated dams impound between 16-93,952 acre feet of water each (mean = 4,130) (USACE 2006). The Gulf of Maine DPS contains 83 dams that are regulated by FERC that generally occur on larger tributaries or on the mainstem rivers (USACE 2005), and approximately 392 dams that are not regulated by FERC that generally occur on smaller tributaries and not on larger rivers (NOAA 2010). The non-FERC regulated dams range from small mill dams to larger dams owned by state, federal, and non-federal entities and include dilapidated mill dams, reservoir dams, and water level management structures constructed of stone, earth, timber, and concrete or some combination of these materials (Kleinschmidt Associates 2010). As with many old dams, fish passage structures are generally not present or may be in disrepair (Kleinschmidt Associates 2010), which typically results in impaired and very limited fish passage during differing flow conditions.

Fish Passage

Dams can prevent or impair fish passage of Atlantic salmon and other diadramous fish species both upstream and downstream of the dam (Fay *et al.* 2006). Approximately 44-49% of all historical Atlantic salmon habitat is currently inaccessible due to barriers to fish passage. If a dam does not have a fishway, or the fishway is improperly designed or maintained, access to upstream spawning and rearing habitat can be restricted (Fay *et al.* 2006). Installation of a fishway does not ensure passage, as no fishway is 100% effective. As a result, the more fishways encountered by migrating salmon, the less likely they are to achieve passage to spawning grounds or the ocean.

Adult salmon that cannot pass a fishway will either spawn in downstream areas, return to the ocean without spawning, or die in the river. These salmon are significantly affected by the presence of fishways. Although no studies have looked directly at the fate of fish that fail to pass through upstream fish passage facilities, we convened an expert panel in 2010 to provide the best available information on the fate of these fish on the Penobscot River. The panel was comprised of state, federal, and private sector Atlantic salmon biologists and engineers with expertise in Atlantic salmon biology and behavior at fishways. The group estimated a baseline mortality rate of 1% for Atlantic salmon that fail to pass a fishway at a given dam on the Penobscot River (NMFS 2011). Additional mortality was assumed based on project specific factors, such as predation, fish handling, high fall back rates, lack of thermal refugia, etc. Although the expert panel was specifically addressing the fate of fish at hydroelectric projects on the Penobscot River, the effects are consistent with what would be expected at small dams throughout the Gulf of Maine DPS.

Hydroelectric dams can cause injury or mortality to juvenile salmon that attempt to pass the projects as they migrating downstream to the estuary. Fish can become injured or killed by becoming entrained while passing through turbines, or by becoming impinged on the screen or trash rack at the intake (Fay *et al.* 2006). Both entrainment and impingement can result in mortality as well as prevent fish passage. Although entrainment and impingement are not

[9] Maine's list of non-FERC dams was populated by a voluntary program which ran from 1983-1993. This registration required a minimum height and water capacity, therefore a much larger number of dams likely exists within the State (GMCME 2010).

significant factors at non-hydroelectric dams, injury and mortality of Atlantic salmon smolts and kelts is still expected due to downstream passage over dam spillways. Based on field trials assessing fish passage over spillways at five hydroelectric dams, only 97.1% of smolts are likely to survive passage via spillage (Normandeau Associates, Inc. 2011). Similarly, Alden Research Laboratory (2012) estimated 3% mortality due to spillway passage at all the mainstem hydroelectric projects on the Penobscot River.

Migratory Delay

Early migration is an adaptive trait that ensures adult Atlantic salmon have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Gorsky (2005) found that migration in Atlantic salmon was significantly affected by flow and temperature conditions in the Penobscot River. He found that high flow led to a decrease in the rate of migration and that rates increased with temperature up to a point (around 23°C) where they declined rapidly. To avoid high flows and warmer temperatures in the river, Atlantic salmon have adapted to migrating in the late spring and early summer, even though spawning does not occur until October and November. Between 2007 and 2010, 78% of migrating Atlantic salmon migrated past the first dam on the Penobscot River in May and June.

To access high quality summer holding areas close to spawning areas in the Gulf of Maine DPS, Atlantic salmon must migrate past multiple dams. Delay at these dams can, individually and cumulatively, affect an individual's ability to access suitable spawning habitat within the narrow window when temperature and flow conditions in the river are suitable for migration. In addition, delays in migration can cause overripening of eggs, which can lead to increased chance of egg retention, and reduced egg viability in pre-spawn female salmonids (deGaudemar and Beall 1998). It is not known what level of delay at each dam would significantly affect a migrant's ability to access suitable spawning habitat, as it would be different for each individual and tributary, and would vary from year to year depending on environmental conditions. Accordingly, we believe that 48 hours provide adequate opportunity for pre-spawn adult Atlantic salmon to locate and use well-designed upstream fishways without leading to deleterious effects to the spawning success of the individual.

Dams can also delay smolt migration to the ocean, which can lead to direct mortality through increased predation (Blackwell and Juanes 1998) and delayed mortality by affecting physiological health or preparedness for marine entry and migration (Budy *et al.* 2002). Delays in migration may cause salmon to lose physiological smolt characteristics due to high water temperatures during spring migration, and can result in progressive misalignment of physiological adaptations to seawater entry; thereby, reducing smolt survival (McCormick *et al.* 1999). Lastly, because Atlantic salmon often encounter multiple dams during their migratory life cycle, losses are cumulative and often biologically significant (Fay *et al.* 2006).

Delayed Effects of Downstream Passage

In addition to direct mortality sustained by Atlantic salmon at dams, Atlantic salmon in the Gulf of Maine DPS sustain delayed mortality as a result of repeated passage events at multiple dams. Studies have investigated what is referred to as latent or delayed mortality, which occurs in the estuary or ocean environment and is associated with passage through one or more hydroelectric projects (Budy *et al.* 2002; ISAB 2007; Schaller and Petrosky 2007; Haeseker *et al.* 2012). The concept describing this type of mortality is known as the hydrosystem-related, delayed-mortality hypothesis (Budy *et al.* 2002; Schaller and Petrosky 2007; Haeseker *et al.* 2012).

Budy *et al.* (2002) examined the influence of hydrosystem experience on estuarine and early ocean survival rates of juvenile salmonids migrating from the Snake River to test the hypothesis that some of the mortality that occurs after downstream migrants leave a river system may be due to cumulative effects of stress and injury associated with multiple dam passages. The primary factors leading to hydrosystem stress (and subsequent delayed mortality) cited by Budy *et al.* (2002) were dam passage (turbines, spillways, bypass systems), migration conditions (e.g., flow, temperature), and collection and transport around dams, all of which could lead to increased predation, greater vulnerability to disease, and reduced fitness associated with compromised energetic and physiological condition.

Predation

Smallmouth bass and chain pickerel are each important predators of Atlantic salmon within the range of the Gulf of Maine DPS (Fay *et al.* 2006). Smallmouth bass are a warm-water species whose range now extends through north-central Maine and well into New Brunswick (Jackson 2002). Smallmouth bass likely feed on fry and parr though little quantitative information exists regarding the extent of bass predation upon salmon fry and parr. Smallmouth bass are important predators of smolts in main stem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993).

Chain pickerel are known to feed upon fry and parr, as well as smolts within the range of the Gulf of Maine DPS, given their piscivorous feeding habits (Van den Ende 1993). Chain pickerel feed actively in temperatures below 10°C (Van den Ende 1993, MDIFW 2002). Smolts were, by far, the most common item in the diet of chain pickerel observed by Barr (1962) and Van den Ende (1993). However, Van den Ende (1993) concluded that, "daily consumption was consistently lower for chain pickerel than that of smallmouth bass", apparently due to the much lower abundance of chain pickerel.

Northern pike were illegally stocked in Maine, and their range now includes portions of the Gulf of Maine DPS. Northern pike are ambush predators that rely on vision and thus, predation upon smolts occurs primarily in daylight with the highest predation rates in low light conditions at dawn and dusk (Bakshtansky *et al.* 1982). Hatchery smolts experience higher rates of predation by fish than wild smolts, particularly from northern pike (Ruggles 1980, Bakshtansky *et al.* 1982).

Many species of birds prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell *et al.* (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at main stem dam foraging sites. Common mergansers, belted kingfishers cormorants, and loons prey would likely prey upon Atlantic salmon in the Androscoggin River. The abundance of alternative prey resources such as upstream migrating alewife, likely minimizes the impacts of cormorant predation on the Gulf of Maine DPS (Fay *et al.* 2006).

Contaminants and Water Quality
Pollutants discharged from point sources affect water quality within the action area of this consultation. Common point sources of pollutants include publicly operated waste treatment facilities, overboard discharges (OBD), and industrial sites and discharges. The Maine Department of Environmental Protection (DEP) 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. Generally, the impacts of point source pollution are greater in the larger rivers of the Gulf of Maine DPS that have not met water quality criteria. The DEP has a schedule for preparing a number of Total Maximum Daily Load (TMDL) analyses for rivers and streams within the Gulf of Maine DPS. TMDLs allocate a waste load for a particular pollutant for impaired waterbodies.

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

5.0 ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, Federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of ESA-listed species in the action area.

5.1 Federal Actions that have Undergone Section 7 Consultation

NMFS has undertaken several ESA section 7 consultations to address the effects of various Federal actions on threatened and endangered species in the action area. Each of those consultations sought to develop ways of reducing the probability of adverse impacts of the action on listed species.

5.1.1 Authorization of Fisheries through Fishery Management Plans

NMFS authorizes the operation of several fisheries in the action area under the authority of the Magnuson-Stevens Fishery Conservation Act and through FMPs and their implementing regulations. Commercial and recreational fisheries in the action area employ gear that is known to harass, injure, and/or kill sea turtles, Atlantic sturgeon, and Atlantic salmon. However, adverse effects from these fisheries on sperm whales and shortnose sturgeon are not anticipated.

In the Greater Atlantic Region (Maine through Virginia), formal ESA section 7 consultations have been conducted on the American lobster; batched Northeast multispecies, monkfish, spiny dogfish, Atlantic bluefish, Northeast skate complex, Atlantic mackerel/squid/butterfish, and summer flounder/scup/black sea bass; Atlantic sea scallop; red crab; and tilefish fisheries. Each of these consultations has considered adverse effects to loggerhead, green, Kemp's ridley and leatherback sea turtles. In each of the Opinions on these fisheries, we concluded that the ongoing action was likely to adversely affect but was not likely to jeopardize the continued existence of any sea turtle species. Each of these Opinions included an Incidental Take Statement (ITS) exempting a certain amount of lethal or non-lethal take resulting from interactions with the fishery. These ITSs are summarized in the table below (Table 11). Further, in each Opinion, we concluded that the potential for interactions (i.e., vessel strikes) between sea turtles/Atlantic sturgeon/Atlantic salmon and fishing vessels was extremely low and similarly that any effects to their prey and/or habitat would be insignificant and discountable. We have also determined that the Atlantic herring, Atlantic surf clam, and ocean quahog fisheries do not adversely affect any ESA-listed species.

NMFS's Southeast Regional Office (SERO) has carried out formal ESA section 7 consultations for several FMPs with action areas that at least partially overlap with the action area. These include: coastal migratory pelagics, swordfish/tuna/shark/billfish (highly migratory species), snapper/grouper, dolphin/wahoo, and the Southeast shrimp trawl fisheries. The ITSs provided with these Opinions are also included in Table 11.

In addition to these consultations, NMFS has conducted a formal consultation on the pelagic longline component of the Atlantic highly migratory species FMP. Portions of this fishery occur within the action area. In a June 1, 2004 Opinion, NMFS concluded that the ongoing action was likely to adversely affect but was not likely to jeopardize the continued existence of loggerhead, Kemp's ridley or green sea turtles but was likely to jeopardize the continued existence of leatherback sea turtles. This Opinion included a Reasonable and Prudent Alternative (RPA) that when implemented would modify operations of the fishery in a way that would remove jeopardy. This fishery is currently operated in a manner that is consistent with the RPA. The RPA included an ITS which is reflected in Table 11 above. Unless specifically noted, all numbers denote an annual number of captures that may be lethal or non-lethal.

Table 11. Dates of the most recent Opinions prepared by NMFS GARFO and SERO for federally managed fisheries in the action area and their respective ITSs for sea turtles. Unless noted, levels of incidental take exempted are on an annual basis.

	Date	Loggerhead	Kemp's ridley	Green	Leatherback
GARFO FMPs					
American lobster	July 31, 2014	1 (lethal or non-lethal)	0	0	7 (lethal or non-lethal)
Northeast Multispecies, Monkfish, Spiny Dogfish, Atlantic Bluefish, Northeast Skate Complex, Mackerel/Squid/Butterfish, and Summer Flounder/ Scup/Black Sea Bass (Batched Fisheries)	December 16, 2013 (ITS amended March 10, 2016)	1,345 (835 lethal) every 5 years in gillnets; 1,020 (335 lethal) every 5 years in bottom trawls; 1 (lethal or non-lethal) annually in pot/trap gear	4 (3 lethal) annually in gillnets; 3 (2 lethal) annually in bottom trawls	4 (3 lethal) annually in gillnets; 3 (2 lethal) annually in bottom trawls	4 (3 lethal) annually in gillnets; 4 (2 lethal) annually in bottom trawls; 4 (lethal or non-lethal) annually in pot/trap gear
Atlantic sea scallop	July 12, 2012 (ITS amended May 1, 2015)	322 (92 lethal) every 2 years in dredges; 700 (330 lethal) every 5 years in trawls	3 (2 lethal) in dredges and trawls combined	2 (lethal) in dredges and trawls combined	2 (lethal) in dredges and trawls combined
Red Crab	February 6, 2002	1 (lethal or non-lethal)	0	0	1 (lethal or non-lethal)
Tilefish	March 13, 2001	6 (no more than 3 lethal)	0	0	1 (lethal or non-lethal)
SERO FMPs					
Coastal migratory pelagics	June 18, 2015	27 every 3 years (7 lethal)	8 every 3 years (2 lethal)	31 every 3 years (9 lethal)	1 every 3 years (1 lethal)
Southeastern shrimp trawling*	April 18, 2014	At least 1,000s and possibly 10,000s of interactions (100s to possibly 1,000s lethal)	At least 10,000s and possibly 100,000s of interactions (1,000s to possibly 10,000s lethal)	At least 100s and possibly low 1,000s of interactions (10s to possibly 100s lethal)	A few hundred interactions (10s lethal)
Shark fisheries as managed under the Consolidated HMS FMP	December 12, 2012	126 (78 lethal) every 3 years	36 (21 lethal) every 3 years	57 (33 lethal) every 3 years	18 (9 lethal) every 3 years
South Atlantic snapper-grouper	June 7, 2006	202 (67 lethal) every 3 years	19 (8 lethal) every 3 years	39 (14 lethal) every 3 years	25 (15 lethal) every 3 years
Pelagic longline under the HMS FMP (per the RPA)	June 1, 2004	1,905 (339 lethal) every 3 years	**105 (18 lethal) every 3 years	**105 (18 lethal) every 3 years	1,764 (252 lethal) every 3 years
South-Atlantic dolphin-wahoo***	August 27, 2003	12 (2 lethal) every 3 years	2 (1 lethal) every 3 years	2 (1 lethal) every 3 years	12 (1 lethal) every 3 years

** although the ITS does not provide estimates of incidental take for any sea turtle species, the effects section provides a qualitative assessment of the anticipated number of interactions and mortalities by order of magnitude*
*** combination of 105 (18 lethal) Kemp's ridley, green, hawksbill, or olive ridley*
**** combination of 16 turtles total every 3 years with 2 lethal (Kemp's ridley, green, hawksbill, leatherback)*

Atlantic sturgeon originating from the five DPSs considered in this consultation are known to be captured and killed in a number of these trawl and gillnet fisheries operating in the action area. At the time of this writing, both the Atlantic sea scallop and batched fisheries Opinions cover Atlantic sturgeon interactions in the Greater Atlantic Region. As noted in the *Status of the Species* section above, the NEFSC prepared a bycatch estimate for Atlantic sturgeon captured in sink gillnet and otter trawl fisheries operated from Maine through Virginia. This estimate indicates that, based on data from 2006-2010, annually, an average of 3,118 Atlantic sturgeon are captured in these fisheries with 1,569 in sink gillnet and 1,548 in otter trawls. The mortality rate in sink gillnets is estimated at approximately 20% and the mortality rate in otter trawls is estimated at 5%. Based on this estimate, a total of 391 Atlantic sturgeon are estimated to be killed annually in these fisheries that are prosecuted in the action area. We are currently in the process of determining the effects of this annual loss to each of the DPSs. Any of these fisheries that operate with sink gillnets or otter trawls are likely to interact with Atlantic sturgeon and be an additional source of mortality in the action area. An updated Atlantic sturgeon bycatch estimate in Northeast gillnet and bottom trawl fisheries for 2011-2015 is expected in mid-2016.

At this time, fisheries regulated by the SERO for which a bycatch estimate is available for Atlantic sturgeon are the Atlantic shark, southeast shrimp trawl, and coastal migratory pelagic fisheries. In their December 12, 2012, Opinion on the Atlantic shark fisheries, the SERO estimated that a total of 321 interactions, of which 66 are expected to be lethal, are likely to occur every three years as a result of these fisheries. The level of interactions and mortalities were expected to be greatest within the NYB DPS, followed by the SA, CB, GOM, and Carolina DPSs. In their April 18, 2014, Opinion on the southeast shrimp trawl fishery, the SERO estimated that a total of 1,773 interactions, including 285 captures (of which 27 are expected to be lethal), are likely to occur every three years as a result of the fishery. The level of interactions, captures, and mortalities were expected to be greatest within the SA DPS, followed by the Carolina, NYB, CB, and GOM DPSs. In their June 18, 2015, Opinion on the coastal migratory pelagics fishery, the SERO estimated that a total of 12 non-lethal interactions are likely to occur every three years as a result of the fishery. The level of interactions and mortality were expected to be greatest within the SA DPS, followed by the Carolina and NYB, CB, and GOM DPSs. Other fisheries in the Southeast that operate with sink gillnets or otter trawls are also likely to interact with Atlantic sturgeon and be an additional source of mortality in the action area.

Atlantic salmon originating from the Gulf of Maine DPS may also be captured and killed in commercial trawl and gillnet fisheries operating in the action area. Based on incidental capture data from observer reports for the fisheries assessed in the 2013 batched fisheries Opinion and the distribution and abundance of Gulf of Maine DPS Atlantic salmon, NMFS anticipated that the continued operation of the seven batched fisheries may result in the observed take of up to five individuals over a five-year average in gillnet gear (of which up two to takes may be lethal), and the observed take of up to five individuals over a five-year average in bottom trawl gear (of which up to three takes may be lethal). The anticipated level of incidental take of Atlantic salmon for the recreational components of the seven fisheries could not be estimated at the time.

5.1.2 Hopper Dredging

The construction and maintenance of Federal navigation channels and sand mining ("borrow") areas have also been identified as sources of sea turtle mortality. Shortnose and Atlantic sturgeon may also be killed during hopper dredging operations, although this is rare. No interactions or mortalities of sperm whales or Atlantic salmon have been documented during dredging activities All hopper dredging projects are authorized or carried out by the U.S. Army Corps of Engineers (ACOE). In the action area, these projects are under the jurisdiction of the districts within the North Atlantic or South Atlantic Divisions. Hopper dredging projects in this area have resulted in the recorded mortality of approximately 87 loggerheads, four greens, nine Kemp's ridleys and four unidentified hard shell turtles since observer records began in 1993. To date, nearly all of these interactions have occurred in nearshore coastal waters with very few interactions in the open ocean. Few interactions between hopper dredges and Atlantic sturgeon have been reported, with just three records documenting interactions between hopper dredges and Atlantic sturgeon in the action area (two in Virginia near the Chesapeake Bay entrance, and one in the New York Bight). NMFS GARFO and SERO have completed several ESA section 7 consultations with the Corps to consider effects of these hopper dredging projects on listed sea turtles. Many of these consultations have been reinitiated to consider effects to Atlantic sturgeon. Recently, the U.S. Navy's Dam Annex Shoreline Protection System Repairs operations and NASA's Wallops Island Shoreline Restoration/Infrastructure Protection Program were determined to cause the entrainment of up to one Atlantic sturgeon from any of the five DPSs for approximately every 9.4 million cubic yards of material removed from the borrow areas. This equated to one and two captures, respectively, from any of the five DPSs over the course of the two projects. Four additional Opinions (one Navy project and three ACOE projects) were also completed in 2012 to assess Atlantic sturgeon interactions in Northeast dredging operations. The table below (Table 12) provides information on Opinions considering dredging projects in the action area and the associated ITS for sea turtles (unless otherwise noted, take estimates are per dredge cycle).

Since 1991, the SERO has issued three regional biological opinions (RBOs) regarding ACOE hopper dredging in the South Atlantic District. Most recently, in September 1997, the SERO issued an RBO on the continued hopper dredging of channels and borrow areas in the southeastern United States, authorizing the take of threatened and endangered species by ACOE dredging activities in the South Atlantic District. To date, use of hopper dredges in ACOE activities in northeast Florida and Georgia has been limited under the 1997 RBO to operating between December 1 through April 15, except in emergency situations, and the dredging projects have had to abide by the reasonable and prudent measures, and terms and conditions set forth in the 1997 RBO. Federal actions that are consistent with the RBO fall under its ITS, which set an annual documented incidental take for the region of seven Kemp's ridley, seven green, two hawksbill, and 35 loggerhead sea turtles. Other federal actions that are not within the scope of the RBO have undergone separate consultations, for which we have issued Opinions and ITSs.

Table 12. Information on consultations conducted by NMFS for dredging projects that occur in the action area, and their respective ITSs for sea turtles.

Project	Date of Opinion	Loggerhead	Kemp's ridley	Green	Leatherback	Notes
ACOE Continued Hopper Dredging of Channels and Borrow Areas in the SE U.S.	9/25/1997	35	7	7	0	annual estimate for the Southeast U.S. (North Carolina to Key West, Florida)
ACOE Atlantic Coast of Maryland Shoreline Protection Project	11/30/2006	1 (≤0.5 million cy); 2 (>0.5 to ≤1 million cy); 3 (>1 to ≤1.5 million cy); 4 (>1.5 to ≤1.6 million cy)	2	0	0	over life of project (through 2044), ~10-12 million cy will be dredged with an anticipated 24 turtles killed (2 Kemp's ridleys, 22 loggerheads)
ACOE Sconset Beach Dredge and Nourishment Project	10/5/2007	1 (≤2 million cy); 2 (>2 million cy)	0	0	0	
U.S. Navy Shoreline Restoration and Protection Project, JEB Little Creek/ Fort Story, VA Beach	7/13/2012	1 loggerhead or Kemp's ridley		0	0	
U.S. Navy Shoreline Protection Sys Repairs, Naval Air Station Oceana, Dam Neck Annex, VA Beach	7/20/2012	1 loggerhead or Kemp's ridley		0	0	
NASA Wallops Isl Shoreline Restoration/ Infrastructure Protection Program	8/3/2012	up to 9	no more than 1	0	0	total takes over 50-year project life

ACOE Dredging of Chesapeake Bay Entrance Channels and Beach Nourishment	10/16/2012	937 non-lethal captures, 452 mortalities	275 non-lethal captures, 48 mortalities	38 non-lethal captures, 11 mortalities	0	total takes over 50-year project life
		Relocation Trawling: up to 938 captures (37 mortalities) of loggerheads, 275 captures (11 mortalities) of Kemp's ridleys, and 37 captures (2 mortalities) of green sea turtles				
ACOE NY and NJ Harbor Deepening	10/25/2012	1 loggerhead or Kemp's ridley		0	0	total takes over 50-year project life
ACOE Maintenance of the 40-foot Delaware River Federal Navigation Channel	8/1/2013	1 loggerhead or Kemp's ridley		0	0	total takes in hopper dredging from 2013-2017
ACOE Sea Bright Offshore Borrow Area Beach Nourishment	3/7/2014	Port Monmouth: 1 loggerhead or Kemp's ridley; Union Beach: 1 loggerhead or Kemp's ridley; Elberon to Loch Arbour: 5 loggerheads and 1 loggerhead or Kemp's ridley (all lethal or non-lethal)		0	0	total takes over 50-year project life
ACOE Sand borrow areas for beach nourishment and hurricane protection, offshore DE and NJ	6/26/2014	29	2	1	0	total takes over 50-year project life
ACOE Delaware Deepening	11/20/2015	11	2	0	0	total takes over 15-year project life

5.1.3 Vessel Activity and Military Operations

Potential sources of adverse effects to sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon from Federal vessel operations in the action area include operations of the U.S. Navy, U.S. Coast Guard (USCG), Bureau of Ocean Energy Management (BOEM), Maritime Administration (MARAD), Environmental Protection Agency (EPA), and ACOE to name a few. NMFS has previously conducted formal consultations with the Navy and USCG on their vessel-based operations. NMFS has also conducted section 7 consultations with BOEM and MARAD on vessel traffic related to energy projects in the Greater Atlantic Region and has implemented conservation measures. Through the section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. To date, ocean-going vessels and military activities have not been identified as significant threats to shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon. However, the possibility exists for interactions between vessels and these species in marine, estuarine, and riverine environments. However, because of a lack of information on the effects of these activities on sturgeon and salmon, the discussion below focuses on large whales and sea turtles.

Although consultations on individual Navy and USCG activities have been completed, only one formal consultation on overall military activities in all of the Atlantic has been completed at this time. In June 2009, NMFS prepared an Opinion on Navy activities in each of their four training range complexes along the U.S. Atlantic coast—Northeast, Virginia Capes, Cherry Point, and Jacksonville (NMFS 2009a). In addition, the following Opinions for the Navy (NMFS 1996, 1997, 2008b, 2009b) and USCG (NMFS 1995, 1998) contain details on the scope of vessel operations for these agencies and the conservation measures that are being implemented as standard operating procedures. In the U.S. Atlantic, the operation of USCG boats and cutters is estimated to take no more than one individual sea turtle, of any species, per year (NMFS 1995).

Military activities such as ordnance detonation also affect listed species of large whales and sea turtles. A section 7 consultation was conducted in 1997 for Navy aerial bombing training in the ocean off the southeast U.S. coast, involving drops of live ordnance (500 and 1,000-lb bombs). The resulting Opinion for this consultation determined that the activity was likely to adversely affect sea turtles but would not jeopardize their continued existence. In the ITS included within the Opinion, these training activities were estimated to have the potential to injure or kill, annually, 84 loggerheads, 12 leatherbacks, and 12 greens or Kemp's ridleys, in combination (NMFS 1997).

NMFS has also conducted more recent section 7 consultations on Navy explosive ordnance disposal, mine warfare, sonar testing (e.g., AFAST, SURTASS LFA), and other major training exercises (e.g., bombing, Naval gunfire, combat search and rescue, anti-submarine warfare, and torpedo and missile exercises) in the Atlantic Ocean. These consultations have determined that the proposed Navy activities may adversely affect but would not jeopardize the continued existence of ESA-listed whales and sea turtles (NMFS 2008b, 2009a, 2009b). NMFS estimated that five loggerhead and six Kemp's ridley sea turtles are likely to be harmed as a result of training activities in the Virginia Capes Range Complex from June 2009 to June 2010, and that nearly 1,500 sea turtles, including ten leatherbacks, are likely to experience harassment (NMFS 2009a).

Similarly, operations of vessels by other Federal agencies within the action area (BOEM, MARAD, EPA, and ACOE) may adversely affect large whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon. However, vessel activities of those agencies are often limited in scope, as they operate a limited number of vessels or are engaged in research/operational activities that are unlikely to contribute a large amount of risk.

5.1.4 Research and Other Permitted Activities

Research activities either conducted or funded by Federal agencies within the action area may adversely affect ESA-listed marine mammals, sea turtles, and fish, and may require a section 7 consultation. Several section 7 consultations on research activities have recently been completed, as described below.

Fish Surveys funded by the USFWS
USFWS Region 5 provides funds to 13 States and the District of Columbia under the Dingell-Johnson Sport Fish Restoration Grant program and the State Wildlife Grant Program. Vermont and West Virginia are the only two Northeast States that do not use these funds to conduct ongoing surveys in marine, estuarine or rivervine waters where NMFS listed species are present. The 11 other States (Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia) and the District of Columbia carry out a total of 86 studies, mostly on an annual basis. There are several broad categories of fisheries surveys including: hook and line; beach seine; bottom trawl; fishway trap; boat electrofishing; long line; fyke net; gill net; haul seine; push net; and, backpack electrofishing. These surveys occur in state waters (rivers, estuaries, and in nearshore ocean waters), generally from Maine through Virginia.

A Biological Opinion completed by us in 2013 bundled the eleven independent actions carried out by the USFWS (i.e., awarding of each grant fund to each state is an independent action). The Opinion provides an ITS by activity and provided a summary by state. Overall, we anticipate that the surveys described in the Opinion, to be funded by FWS and carried out by the states over a five-year period, will result in the capture of:

- A total of 18 shortnose sturgeon plus one in the Westfield River fish passage facility and 36 interactions during electrofishing activities;
- A total of 32 sea turtles; and,
- A total of no more than 507 Atlantic sturgeon.

The only mortalities that we anticipate are six Atlantic sturgeon (originating from any of the five DPSs) during gillnet surveys carried out by New York, New Jersey, Maryland, and Virginia.

Section 10(a)(1)(A) Permits
NMFS has issued additional research permits under section 10(a)(1)(A) of the ESA, which authorizes activities for scientific purposes or to enhance the propagation or survival of the affected species. The permitted activities do not operate to the disadvantage of the species and are consistent with the purposes of the ESA, as outlined in section 2 of the Act. A total of 56 section 10(a)(1)(A) permits are currently in effect for sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon within U.S. waters of the Atlantic Ocean. No section 10 permits that authorize serious injury or mortality of marine mammals are currently in effect.

Scientific research on ESA-listed Atlantic salmon has been authorized under the USFWS's endangered species blanket permit (No. 697823) under section 10(a)(1)(A), and covers a number of research projects carried out by NMFS and other research partners contracted by NMFS such as the University of Maine. The USFWS is anticipating re-structuring their permits and plan to issue new permits to cover only research directly under the direct supervision of NMFS and will no longer be providing authorization (i.e., sub-permits) for research being conducted by other entities. The USFWS is planning to issue separate permits for different research activities conducted through other agencies or partners such as USGS, Maine DMR, and the University of Maine. This will provide a more efficient way of tracking individual take and will allow the USFWS to have a better understanding of ongoing research and level of take associated with these activities through the annual reporting requirements.

NMFS currently cooperates in research on Atlantic salmon in the Penobscot River to document changes in fish populations resulting from the removal of the Veazie and Great Works Dams as well as the construction of the fish bypass at the Howland Dam. The study uses electrofishing techniques to document baseline conditions in the river prior to construction at the dams. Following dam removal and construction of the fish bypass, researchers will re-sample the river.

NMFS also is monitoring biomass and species composition in the estuary to look at system-wide effects of dam removal projects. Although these activities will result in some take of Atlantic salmon, adverse impacts are expected to be minor and authorized by the existing ESA permit. The information gained from these activities will be used to further salmon conservation actions in the Gulf of Maine DPS.

USFWS is authorized 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% of adult returns to the Gulf of Maine DPS are currently provided through production at the hatcheries. Approximately 600,000 smolts are stocked annually in the Penobscot River. The hatcheries provide a significant buffer from extinction for the species.

Section 10(a)(1)(B) Permits

Section 10(a)(1)(B) of the ESA authorizes NMFS, under some circumstances, to permit non-federal parties to take otherwise prohibited fish and wildlife if such taking is "incidental to, and not the purpose of carrying out otherwise lawful activities" (50 CFR 217-222). As a condition for issuance of a permit, the permit applicant must develop a conservation plan that minimizes negative impacts to the species. There are currently three active Section 10(a)(1)(B) permits:

In addition, most coastal Atlantic states are either in the process of applying for permits or considering applications for state fisheries. Active permits and permit applications are posted online for all species as they become available at http://www.nmfs.noaa.gov/pr/permits/esa_review.htm. We are actively working with several states and other parties on section 10(a)(1)(B) permits; however to date no section 10(a)(1)(B) permits have been authorized for Gulf of Maine DPS Atlantic salmon or ESA-listed cetaceans.

MMPA Incidental Harassment Authorizations and Letters of Authorization

Under Section 101(a)(5) of the MMPA, certain incidental taking of a small number of marine mammals by U.S. citizens who are engaged in an activity other than commercial fishing is allowed through the issuance of Incidental Harassment Authorizations (IHAs) or LOAs. IHAs allow applicants to use an expedited process (4-8 months) for authorization to incidentally "harass" marine mammals as long as there is no potential for serious injury/mortality or the potential for serious injury/mortality can be negated through mitigation measures that could be required under the authorization. If the potential for serious injury/mortality exists and no mitigating measures can be taken to prevent this kind of take, than the applicant must apply for an LOA. The LOA process takes 8-18 months.

The types of activities receiving IHAs and LOAs may involve acoustic harassment or habitat disturbance from yacht races (America's Cup), seismic surveys, exploratory drilling surveys, bridge construction, fireworks displays, sonar testing, Navy training exercises, and light house restorations, among others. The types of authorized takes include behavioral responses, as well as injuries and mortalities. Currently there are no LOAs that allow serious injuries and mortalities for ESA-listed cetaceans. Current and past applications are available for public review at https://apps.nmfs.noaa.gov/. NMFS performs section 7 consultations on the issuance of IHAs and LOAs that may affect listed species.

5.2 Non-Federally Regulated Fisheries

Several fisheries for species that are not managed by a Federal FMP occur in both state and Federal waters of the action area. The amount of gear contributed to the environment by these fisheries is often unknown. In most cases, there is limited observer coverage of these fisheries and the extent of interactions with ESA-listed species is difficult to estimate. Sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon may be vulnerable to capture, injury, and mortality in a number of these fisheries. Captures of both sea turtles (SEFSC 2001; Murray 2009a; Warden 2011a) and Atlantic sturgeon (ASSRT 2007; NMFS Sturgeon Workshop 2011) in these fisheries have been reported.

The available bycatch data for FMP fisheries indicate that sink gillnets and otter trawl gear pose the greatest risk to Atlantic sturgeon (ASMFC TC 2007), although Atlantic sturgeon are occasionally caught by hook and line, fyke nets, and crab pots as well (NMFS Sturgeon Workshop 2011). It is likely that this vulnerability to these types of gear is similar for non-Federal fisheries, although there is little data available to support this. Information on the number of Atlantic sturgeon captured or killed in non-Federal fisheries, which primarily occur in state waters, is extremely limited. An Atlantic sturgeon "reward program," where commercial fishermen were provided monetary rewards for reporting captures of Atlantic sturgeon in Chesapeake Bay, operated from 1996 to 2012 in Maryland (Mangold *et al.* 2007). The data from this program show that Atlantic sturgeon have been caught in a wide variety of gear types, including hook and line, pound nets, gillnets, crab pots, eel pots, hoop nets, trawls, and fyke nets. Pound nets (58.9%) and gillnets (40.7%) accounted for the vast majority of captures. Of the more than 2,000 Atlantic sturgeon reported in the reward program during 11 years (1996-2006), biologists counted ten individuals that died as a result of their capture. No information on post-release mortality is available.

Efforts are currently underway to obtain more information on the numbers of Atlantic sturgeon captured and killed in state-water fisheries and a handful of states (e.g., Delaware, New Jersey, New York, and North Carolina) are in the process of applying for ESA section 10 permits to cover the incidental capture of Atlantic sturgeon in their state fisheries. Preliminary and anecdotal information suggests the numbers of Atlantic sturgeon captured or killed in state-water fisheries is small. Atlantic sturgeon are also vulnerable to capture in state-water fisheries occurring in rivers, such as shad fisheries; however, these riverine areas are outside the action area under consideration in this Opinion. Where available, state-specific information on sea turtle and Atlantic sturgeon interactions in non-Federal fisheries is provided below.

Atlantic croaker fishery

An Atlantic croaker fishery using trawl and gillnet gear also occurs within the action area and sea turtle interactions have been observed in the fishery. The average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the Atlantic croaker fishery was estimated to be 92 loggerhead sea turtles (with a 95% CI of 63-121) from 2009-2013 (Murray 2015a). Additional information on sea turtle interactions with gillnet gear used in the Atlantic croaker fishery has also been recently published by Murray (2013). The average annual bycatch of loggerhead sea turtles in gillnet gear used in the Atlantic croaker fishery, based on VTR data from 2007-2011, was estimated to be 6 per year with a 95% CI of 2-10 (Murray 2013). These estimates encompass the bycatch of loggerheads in the Atlantic croaker fishery in both state and Federal waters.

Atlantic sturgeon interactions have also been observed in the Atlantic croaker fishery, but a quantitative assessment of the number of Atlantic sturgeon captured in the croaker fishery is not available. A mortality rate of Atlantic sturgeon in commercial trawls has been estimated at 5%. A review of the NEFOP database indicates that from 2006-2010, 60 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as croaker. This represents a minimum number of Atlantic sturgeon captured in the croaker fishery during this time period as it only considers trips that included a NEFOP observer onboard.

Weakfish fishery

The weakfish fishery occurs in both state and Federal waters, but the majority of commercially and recreationally caught weakfish are caught in state waters (ASMFC 2002). The dominant commercial gears include gillnets, pound nets, haul seines, flynets, and trawls, with the majority of landings occurring in the fall and winter months (ASMFC 2002). Weakfish landings were dominated by the trawl fishery through the mid-1980s, after which gillnet landings began to account for most weakfish landed (ASMFC 2002). North Carolina has accounted for the majority of the annual landings since 1972 while Virginia ranks second, followed by New Jersey (ASMFC 2002). Sea turtle bycatch in the weakfish fishery has occurred (Murray 2013, 2015a) and NMFS originally assessed the impacts of the fishery on sea turtles in an Opinion back in 1997 (NMFS 1997b). Currently, the average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the weakfish fishery is estimated to be 0 loggerheads (with a 95% CI of 0-1) from 2009-2013 (Murray 2015a). Additional information on loggerhead sea turtle interactions with gillnet gear has also been recently published by Murray (2009a, 2009b). The average annual bycatch of loggerhead sea turtles in gillnet gear used in the weakfish fishery, based on VTR data from 2002-2006, was estimated to be one per year with a 95% CI of 0-1 (Murray 2009b), although the more recent Murray (2013) gillnet bycatch estimate for 2007-2011 does not include a loggerhead bycatch estimate for the weakfish gillnet fishery. These estimates encompass the bycatch of loggerheads in the weakfish fishery in both state and Federal waters.

A quantitative assessment of the number of Atlantic sturgeon captured in the weakfish fishery is not available. A mortality rate of Atlantic sturgeon in commercial trawls has been estimated at 5%. A review of the NEFOP observer database indicates that from 2006-2010, 36 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as weakfish. This represents a minimum number of Atlantic sturgeon captured in the weakfish fishery during this time period as it only considers observed trips, and most inshore fisheries are not observed. An earlier review of bycatch rates and landings for the weakfish fishery reported that the weakfish-striped bass fishery had an Atlantic sturgeon bycatch rate of 16% from 1989-2000; the weakfish-Atlantic croaker fishery had an Atlantic sturgeon bycatch rate of 0.02%, and the weakfish fishery had an Atlantic sturgeon bycatch rate of 1.0% (ASSRT 2007).

Whelk fishery

A whelk fishery using pot/trap gear is known to occur in several parts of the action area, including waters off of Maine, Massachusetts, Connecticut, New York, New Jersey, Delaware, Maryland, and Virginia. Landings data for Delaware suggests that the greatest effort in the whelk fishery for waters off of that state occurs in the months of July and October; times when sea turtles are present. Whelk pots, which unlike lobster traps are not fully enclosed, have been suggested as a potential source of entrapment for loggerhead sea turtles that may be enticed to enter the trap to get the bait or whelks caught in the trap (Mansfield *et al*. 2001). Loggerhead, leatherback, and green sea turtles are known to become entangled in lines associated with pot/trap gear used in several fisheries including lobster, whelk, and crab species (SEFSC 2001; Dwyer *et al*. 2002: NMFS 2007b). Whelk fisheries in Massachusetts, New York, New Jersey, and Virginia were verified as the fisheries involved in 18 sea turtle entanglements from 2001 to 2010. Twelve entanglement events involved a leatherback sea turtle, five involved a loggerhead sea turtle, and one involved a green sea turtle (Northeast Region Sea Turtle Disentanglement Network [STDN] database). Whelk pots are not known to interact with Atlantic sturgeon.

Crab fisheries

Various crab fisheries, such as horseshoe crab and blue crab, also occur in Federal and state waters. Loggerhead, leatherback, and green sea turtles are known to become entangled in lines associated with pot/trap gear used in several fisheries including lobster, whelk, and crab species (SEFSC 2001; Dwyer *et al*. 2002: NMFS 2007b). The Virginia blue crab fishery was verified as the fishery involved in four sea turtle entanglements from 2001 to 2010. Two entanglement events involved a leatherback sea turtle and two involved a loggerhead sea turtle (Northeast Region STDN database).

The crab fisheries may have detrimental impacts on sea turtles beyond entanglement in the fishing gear itself. Loggerheads are known to prey on crab species, including horseshoe and blue crabs. In a study of the diet of loggerhead sea turtles in Virginia waters from 1983 to 2002, Seney and Musick (2007) found a shift in the diet of loggerheads in the area from horseshoe and blue crabs to fish, particularly menhaden and Atlantic croaker. The authors suggested that a decline in the crab species have resulted in the shift and loggerheads are likely foraging on fish captured in fishing nets or on discarded fishery bycatch (Seney and Musick 2007). The physiological impacts of this shift are uncertain although it was suggested as a possible explanation for the declines in loggerhead abundance noted by Mansfield (2006). Other studies have detected seasonal declines in loggerhead abundance coincident with seasonal declines of horseshoe and blue crabs in the same area (Maier *et al*. 2005). While there is no evidence of a decline in horseshoe crab abundance in the Southeast during the period 1995-2003, declines were evident in some parts of the Mid-Atlantic (ASMFC 2004; Eyler *et al*. 2007). Given the variety of loggerheads prey items (Dodd 1988; Burke *et al*. 1993; Bjorndal 1997; Morreale and Standora 1998) and the differences in regional abundance of horseshoe crabs and other prey items (ASMFC 2004; Eyler *et al*. 2007), a direct correlation between loggerhead sea turtle abundance and horseshoe crab and blue crab availability cannot be made at this time. Nevertheless, the decline in loggerhead abundance in Virginia waters (Mansfield 2006), and possibly Long Island waters (Morreale *et al*. 2005), coincident with noted declines in the abundance of horseshoe crab and other crab species raises concerns that crab fisheries may be impacting the forage base for loggerheads in some areas of their range.

Atlantic sturgeon are known to be caught in state water horseshoe crab fisheries, which currently operate in all action area states except New Jersey. Along the U.S. East Coast, hand, trawl, and dredge fisheries account for more than 85% of the commercial horseshoe crab landings in the bait fishery. Other methods used are gillnets, pound nets, and traps (ASMFC 2011a). State waters from Delaware to Virginia are closed to horseshoe crab harvest and landing from January 1 to June 7 (ASMFC 2011a). The majority of horseshoe crab landings in 2010 came from Massachusetts, Virginia, and Delaware. Stein *et al*. (2004) examined bycatch of Atlantic sturgeon using the NMFS sea-sampling/observer database (1989-2000) and found that the bycatch rate for horseshoe crabs was low, at 0.05%. An Atlantic sturgeon "reward program," where commercial fishermen were provided monetary rewards for reporting captures of Atlantic sturgeon in the Maryland waters of Chesapeake Bay, operated from 1996 to 2012 (Mangold *et al*. 2007).[10] The data from this program during the 11-year period of 1996-2006 show that one of 1,395 wild Atlantic sturgeon was found caught in a crab pot (Mangold *et al*. 2007).

Virginia pound net fishery

Sea turtle have been observed to interact with the Virginia pound net fishery, which is contiguous to the action area at the mouth of Chesapeake Bay. Pound nets with large-mesh and stringer leaders set in Virginia waters of Chesapeake Bay have been implicated in sea turtle mortalities as a result of entanglement in the pound net leader, and live sea turtles have also been found in the pounds. As described in section 5.4.5 below, NMFS has taken regulatory action to address sea turtle bycatch in the Virginia pound net fishery. Atlantic sturgeon are also captured in pound nets; however, mortality rates are thought to be very low. No estimate of the number of Atlantic sturgeon caught in pound nets in the action area is currently available.

American lobster trap fishery

An American lobster trap fishery also occurs in state waters of New England and the Mid-Atlantic and is managed under the ASMFC's Interstate Fishery Management Plan (ISFMP). Like the Federal waters component of the fishery mentioned in section 5.1, the state waters fishery has also been identified as a source of gear causing injuries to and mortality of loggerhead and leatherback sea turtles as a result of entanglement in vertical buoy lines of the pot/trap gear. Between 2001 and 2010, lobster trap gear traced back to a fisherman possessing a state permit

[10] The program was terminated in February 2012, with the listing of Atlantic sturgeon under the ESA.

was verified as the gear involved in 33 leatherback entanglements in the Greater Atlantic Region. Of those, 28 were state-permitted only (i.e., they had to have occurred in state waters). The other five could have potentially occurred in Federal waters, as the fisherman either had both state and Federal permits or it was not known if they had a Federal permit. All entanglements involved the vertical line of the gear. These verified/confirmed entanglements occurred in waters off Maine, Massachusetts, Rhode Island, and Connecticut from June through October; the vast majority (27 of the 33) were documented in waters off Massachusetts (Northeast Region STDN database). Atlantic sturgeon are not known to interact with lobster trap gear.

Fish trap, seine, and channel net fisheries
Incidental captures of loggerheads in fish traps have been reported from several states along the U.S. Atlantic coast (Shoop and Ruckdeschel 1989; W. Teas, NMFS, pers. comm.), while leatherbacks have been documented as entangled in the buoy line systems of conch and sea bass traps off Massachusetts (Northeast Region STDN database). Long haul seines, purse seines, and channel nets are also known to incidentally capture sea turtles in sounds and other inshore waters along the U.S. Atlantic coast, although no lethal interactions have been reported (SEFSC 2001). No information on interactions between Atlantic sturgeon and fish traps, long haul seines, purse seines, or channel nets is currently available; however, depending on where this gear is set and the mesh size, the potential exists for Atlantic sturgeon to be entangled or captured in this gear.

Northern shrimp fishery
A Northern shrimp fishery also occurs in state waters of Maine, New Hampshire, and Massachusetts, and is managed under the ASMFC's ISFMP. In 2010, the ISFMP implemented a 126-day season, from December 1 to April 15, but the shrimp fishery has exceeded its TAC and closed early every year, ending on February 17 in 2012. Due to recruitment failure and a collapsed stock, fishing moratoria were instituted by the ASMFC for the 2014, 2015, and 2016 fishing seasons. The majority of northern shrimp are caught with otter trawls, which must be equipped with Nordmore grates (ASMFC NSTC 2011). Otter trawls in this fishery are known to interact with Atlantic sturgeon, but exact numbers are not available (NMFS Sturgeon Workshop 2011). A significant majority (84%) of Atlantic sturgeon bycatch in otter trawls occurs at depths <20 meters, with 90% occurring at depths of <30 meters (Miller 2007). During the spring and fall inshore trawl surveys, northern shrimp are most commonly found in tows with depths of >64 meters (ASFMC NSTC 2011), which is well below the depths at which most Atlantic sturgeon bycatch is occurring. Atlantic sturgeon are known to interact with shrimp trawls, but mortality is low: NEFOP data from 2002-2004 showed 0.2% Atlantic sturgeon mortality in shrimp and otter trawls; Stein *et al*. (2004) reported no immediate Atlantic sturgeon mortality in trawls from 1989-2000 from North Carolina to Maine; and Cooperative Winter Tagging Cruises captured 146 Atlantic sturgeon from 1988-2006, of which none died (Laney *et al*. 2007; ASSRT 2007).

American shad fishery
An American shad fishery also occurs in state waters of New England and the Mid-Atlantic and is managed under the ASMFC's ISFMP. The directed commercial and recreational shad fisheries were closed in all Atlantic coastal states in 2005, with exceptions for sustainable systems as determined through state-specific management programs. Presently, only Connecticut has a directed commercial shad fishery that may occur in the action area, while Maine, New Hampshire, Massachusetts, New York, Rhode Island, Connecticut, New Jersey, and Delaware

have limited recreational fisheries that may occur in the action area. New York's commercial shad fishery had been a problem in the past, but the fishery is now closed.

About 40-500 Atlantic sturgeon were reportedly captured in the spring shad fishery in the past, primarily from the Delaware Bay, with only 2% caught in the river. Effort has more recently switched to striped bass, however. The fishery uses five-inch mesh gillnets left overnight to soak, but, based on the available information, there is little bycatch mortality. Unreported mortality may be occurring in the recreational shad fishery, but the extent is unknown (NMFS Sturgeon Workshop 2011).

Recreational hook and line shad fisheries are known to capture Atlantic sturgeon, particularly in southern Maine, where it is considered to be an "acute" problem (NMFS Sturgeon Workshop 2011). Data from the Atlantic Coast Sturgeon Tagging Database (2000-2004) shows that the shad fishery accounted for 8% of Atlantic sturgeon recaptures. The shad fishery also had one of the highest bycatch rates of 30 directed fisheries according to NMFS Observer Program data from 1989-2000 (ASSRT 2007). However, greater rates of bycatch do not necessarily translate into high mortality rates. Other factors, such as gear, season, and soak times, may be important variables in understanding Atlantic sturgeon mortality.

Striped bass fishery

The striped bass fishery occurs in only in state waters, as Federal waters have been closed to the harvest and possession of striped bass since 1990, except that possession is allowed in a defined area around Block Island, Rhode Island (ASMFC 2011b). The ASMFC has managed striped bass since 1981, and provides guidance to states from Maine to North Carolina through an ISFMP. All states are required to have recreational and commercial size limits, recreational creel limits, and commercial quotas. The commercial striped bass fishery is closed in Maine, New Hampshire, and Connecticut, but open in Massachusetts (hook and line only), Rhode Island, New Jersey (hook and line only), Delaware, Maryland, Virginia, and North Carolina. Recreational striped bass fishing occurs all along the U.S. East Coast.

Several states have reported incidental catch of Atlantic sturgeon (NMFS Sturgeon Workshop 2011). In southern Maine, the recreational striped bass fishery is known to catch Atlantic sturgeon and in New Hampshire, live bait recreational fisheries are also known to catch Atlantic sturgeon, although numbers are not available. The hook and line striped bass fishery along the south shore of Long Island has reports of Atlantic sturgeon bycatch, with hundreds of reports of sturgeon caught or snagged in recreational gear particularly around Fire Island and Far Rockaway. Atlantic sturgeon bycatch is occurring in the Delaware Bay and River, but little bycatch mortality has been reported. Unreported mortality is likely occurring. And in North Carolina, the Winter Beach seine fishery for striped bass is known to capture Atlantic sturgeon (adults and subadults), but has not reported mortalities.

Data from the Atlantic Coast Sturgeon Tagging Database (2000-2004) shows that the striped bass fishery accounted for 43% of Atlantic sturgeon recaptures (ASSRT 2007). The striped bass-weakfish fishery also had one of the highest bycatch rates of 30 directed fisheries according to NMFS Observer Program data from 1989-2000 (ASSRT 2007). However, greater rates of bycatch do not necessarily translate into high mortality rates. Other factors, such as gear, season, and soak times, may be important variables in understanding Atlantic sturgeon mortality.

State gillnet fisheries
Two 10- to 14-inch (25.6- to 35.9-centimeter) mesh gillnet fisheries, the black drum and sandbar shark gillnet fisheries, occur in Virginia state waters along the tip of the eastern shore. Given the gear type, these fisheries may capture or entangle sea turtles. Entanglements of sea turtles in gillnet sets targeting and/or landing both species have been recorded in the NEFOP database. Similarly, sea turtles are thought to be vulnerable to capture in small mesh gillnet fisheries occurring in Virginia state waters. During May-June 2001, NMFS observed 2% of the Atlantic croaker fishery and 12% of the dogfish fishery (which represent approximately 82% of Virginia's total small mesh gillnet landings from offshore and inshore waters during this time), yet no sea turtle captures were observed (NMFS 2004e). Based on gear type (i.e., gillnets), it is likely that Atlantic sturgeon would be vulnerable to capture in these fisheries. An Atlantic sturgeon "reward program" where fishermen were provided monetary rewards for reporting captures of Atlantic sturgeon, operated in the late 1990s in Virginia. The majority of reports of Atlantic sturgeon captures were in drift gillnets and pound nets. No quantitative information on the number of Atlantic sturgeon captured or killed in Virginia fisheries is currently available.

In North Carolina, a large-mesh gillnet fishery for southern flounder in the southern portion of Pamlico Sound is known to incidentally capture sea turtles. ESA section 10 incidental take permits have been issued by NMFS to the state for this fishery in 2000, 2001, 2002, and 2005 (76 FR 61670). The section 10 permit was most recently renewed for the 2005-2010 fishing years with incidental take estimates derived from the 2001-2004 at-sea monitoring program. The 2005-2010 incidental take permit exempted the 'estimated' capture of 41 Kemp's ridley (14 lethal), 168 green (48 lethal), and 41 loggerhead sea turtles (three lethal) over sequential three-year periods (2005-2007, 2008-2010). It also exempted the 'observed' capture of two leatherbacks, two hawksbills, and six Kemp's ridley/green/loggerhead sea turtles (any combination of the three species) over those same time periods. The state of North Carolina is currently reapplying for incidental take coverage for sea turtles for three more years. During 2004, 42 Atlantic sturgeon were observed captured in gillnet fisheries operating in Albemarle and Pamlico Sounds. Of these observed Atlantic sturgeon, five mortalities were reported. A quantitative assessment of the number of Atlantic sturgeon captured or killed in North Carolina state fisheries that occur in the action area is not currently available. The state is currently applying for ESA section 10 coverage of Atlantic sturgeon captures in this fishery.

State recreational fisheries
Observations of state recreational fisheries have shown that loggerhead, leatherback, and green sea turtles are known to bite baited hooks, and loggerheads frequently ingest the hooks. Hooked sea turtles have been reported by the public fishing from boats, piers, beaches, banks, and jetties, and from commercial fishermen fishing for snapper, grouper, and sharks with both single rigs and bottom longlines (SEFSC 2001). A summary of known impacts of hook-and-line captures on loggerhead sea turtles can be found in the TEWG (1998, 2000, 2009) reports. Stranding data also provide some evidence of interactions between recreational hook-and-line gear and sea turtles, but assigning the gear to a specific fishery is rarely, if ever, possible. Atlantic sturgeon have also been observed captured in hook-and-line gear, yet the number of interactions that occur annually

is unknown. While most Atlantic sturgeon are likely to be released alive, we currently have no information on post-release survival. NMFS is currently working on a project to assess the extent of sea turtle interactions that occur in recreational fisheries of the Southeast (North Carolina to Florida) and believes that the survey platform and questionnaire may also be applicable for determining the amount of Atlantic sturgeon interactions as well.

5.3 Other Activities

5.3.1 Maritime Industry

Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on ESA-listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. It is important to note that minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so it is more likely to become vulnerable to effects such as entanglement. Listed species may also be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals through the food chain. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger oil spills may result from severe accidents, although these events would be rare and involve small areas. No direct adverse effects on listed sperm whales, sea turtles, shortnose and Atlantic sturgeon, or Atlantic salmon resulting from fishing vessel fuel spills have been documented.

5.3.2 Pollution

Anthropogenic sources of marine pollution, while difficult to attribute to a specific Federal, state, local, or private action, may affect sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon in the action area. Sources of pollutants in the action area include atmospheric loading of pollutants such as PCBs; storm water runoff from coastal towns, cities, and villages; runoff into rivers emptying into bays; groundwater discharges; sewage treatment plant effluents; and oil spills. The pathological effects of oil spills on sea turtles have been documented in several laboratory studies (Vargo *et al.* 1986).

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, is known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effect to larger embayments is unknown. Contaminants could degrade habitat if pollution and other factors reduce the food available to marine animals.

5.3.3 Coastal Development

Beachfront development, lighting, and beach erosion control all are ongoing activities along the Mid- and South Atlantic coastlines of the U.S. These activities potentially reduce or degrade sea turtle nesting habitats or interfere with hatchling movement to sea. Nocturnal human activities along nesting beaches may also discourage sea turtles from nesting sites. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties are adopting stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting. Coastal development may also impact sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon if it disturbs or degrades foraging habitats or otherwise affects the ability of these species to use coastal habitats.

5.3.4 Global Climate Change and Ocean Acidification

In addition to the information on climate change presented in the *Status of the Species* section for sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon, the discussion below presents further background information on global climate change as well as past and projected effects of global climate change throughout the range of the ESA-listed species considered in this Opinion. Below is the available information on projected effects of climate change in the action area and how listed whales, sea turtles, and fish may be affected by those projected environmental changes. The effects are summarized on the time span of the proposed action, for which we can realistically analyze impacts, yet are discussed and considered for longer time periods when feasible.

In its Fifth Assessment Report (AR5) from 2013, the Intergovernmental Panel on Climate Change (IPCC) stated that the globally averaged combined land and ocean surface temperature data has shown a warming of 0.85°C (likely range: 0.65° to 1.06°C) over the period of 1880-2012. Similarly, the total increase between the average of the 1850-1900 period and the 2003-2012 period is 0.78°C (likely range: 0.72° to 0.85°C). On a global scale, ocean warming has been largest near the surface, with the upper 75 meters of the world's oceans having warmed by 0.11°C (likely range: 0.09° to 0.13°C) per decade over the period of 1971-2010 (IPCC 2013). In regards to resultant sea level rise, it is very likely that the mean rate of global averaged sea level rise was 1.7 millimeters/year (likely range: 1.5 to 1.9 millimeters/year) between 1901 and 2010, 2.0 millimeters/year (likely range: 1.7 to 2.3 millimeters/year) between 1971 and 2010, and 3.2 millimeters/year (likely range: 2.8 to 3.6 millimeters/year) between 1993 and 2010.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next several decades. The global mean surface temperature change for the period 2016-2035 relative to 1986-2005 will likely be in the range of 0.3° to 0.7°C (medium confidence). This assessment is based on multiple lines of evidence and assumes there will be no major volcanic eruptions or secular changes in total solar irradiance. Relative to natural internal variability, near-term increases in seasonal mean and annual mean temperatures are expected to be larger in the tropics and subtropics than in mid- and high latitudes (high confidence). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has also resulted in increased river discharge and glacial and sea-ice melting (Greene *et al.* 2008). The strongest ocean warming is projected for the surface in tropical and Northern Hemisphere subtropical regions. At greater depths, the warming will be most pronounced in the Southern Ocean (high confidence). Best estimates of ocean warming in the top 100 meters are about 0.6° to 2.0°C, and about 0.3° to 0.6°C at a depth of about 1,000 meters by the end of the 21st century (IPCC 2013).

Under Representative Concentration Pathway (RCP) 8.5, the projected change in global mean surface air temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986-2005 is as follows. Global average surface temperatures are likely to be 2.0°C higher (likely range: 1.4° to 2.6°C) from 2046-2065 and 3.7°C higher (likely range: 2.6° to 4.8°C) from 2081-2100. Global mean sea levels are likely to be 0.30 meters higher (likely range: 0.22 to 0.38 meters) from 2046-2065 and 0.63 meters higher (likely range: 0.45 to 0.82 meters) from 2081-2100, with a rate of sea level rise during 2081-2100 of 8 to 16 millimeters/year (medium confidence).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (IPCC 2007; Greene *et al.* 2008). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the Earth's atmosphere caused by anthropogenic forces (IPCC 2007). The NAO impacts climate variability throughout the Northern Hemisphere (IPCC 2007). Data from the 1960s through the 2000s showed that the NAO index increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2007). This warming extends over 1,000 meters deep and is deeper than anywhere in the world's oceans and is particularly evident under the Gulf Stream/North Atlantic Current system (IPCC 2007). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (IPCC 2007; Greene *et al.* 2008). There is evidence that the NADW has already freshened significantly (IPCC 2007). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the entire world (Greene *et al.* 2008).

There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007). These trends have been most apparent over the past few decades, although this may also be due to increased research. Information on future impacts of climate change in the action area is discussed below.

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the action area, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Additional information on potential effects of climate change specific to the action area is discussed below. Warming is very likely to continue in the U.S. over the next 50 years regardless of reduction in greenhouse gases, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 50 years, and it is possible that they will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

Expected consequences of climate change for river systems could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources along the U.S. Atlantic coast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development will experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2^{o}C per decade; and 3) a rise in sea level (NAST 2000). Sea level is expected to continue rising; during the 20th century global sea level has increased 15 to 20 centimeters. It is also important to note that ocean temperature in the U.S. Northeast Shelf and surrounding Northwest Atlantic waters have warmed faster than the global average over the last decade (Pershing *et al.* 2015). New projections for the U.S. Northeast Shelf and Northwest Atlantic Ocean suggest that this region will warm two to three times faster than the global average and thus existing projections from the IPCC may be too conservative (Saba *et al.* 2015).

Effects on sperm whales, sea turtles, sturgeon, and salmon globally

Sperm whales

The impact of climate change on sperm whales is likely to be related to changes in sea temperatures, potential freshening of sea water due to melting ice and increased rainfall, sea level rise, the loss of polar habitats, and potential shifts in the distribution and abundance of prey species. Of the main factors affecting distribution of large whales, water temperature appears to be the main influence on geographic ranges (MacLeod 2009). As such, depending on habitat preferences, changes in water temperature due to climate change may affect the distribution of sperm whales. However, sperm whales are distributed in all water temperature zones. As a result, it is unlikely that their range and conservation status will be directly affected by an increase in water temperatures (MacLeod 2009).

In regards to sperm whale prey, there are many potential direct and indirect effects that global climate change may have on prey abundance and distribution, which in turn, poses potential behavioral and physiological effects to sperm whales. Changes in climate patterns, ocean currents, storm frequency, rainfall, salinity, melting ice, and an increase in river inputs/runoff (nutrients and pollutants) will all directly affect the distribution, abundance, and migration of prey species (Tynan and DeMaster 1997; Waluda *et al*. 2001; Learmonth *et al*. 2006). These changes will likely have several indirect effects on sperm whales, which may include changes in distribution (including displacement from ideal habitats), fitness of individuals, population size (due to the potential loss of foraging opportunities), abundance, migration, community structure, resistance to disease and contaminants, and reproductive success (Macleod 2009). Cephalopods such as squid dominate the diet of sperm whales, who would likely re-distribute following changes in the distribution and abundance of their prey. If, however, cephalopod populations collapse or decline dramatically, sperm whales would likely decline as well. Long-term shifts of sperm whale prey in the California Current have been attributed to the re-distribution of their prey resulting from climate-based shifts in oceanographic variables (Salvadeo *et al*. 2011). Global climate change may also result in changes to the range and abundance of competitors and predators which will also indirectly affect sperm whales (Learmonth *et al*. 2006). In regards to potential reproductive effects of climate change, sperm whale females were observed to have lower rates of conception following unusually warm sea surface temperature periods (Whitehead 1997). At this time, more information is needed in order to determine the potential impacts global climate change will have on the timing and extent of sperm whale movements, abundance, recruitment, distribution, and species composition of prey (Learmonth *et al*. 2006).

Sea turtles

Sea turtle species have persisted for millions of years and throughout this time have experienced wide variations in global climate conditions and have successfully adapted to these changes. As such, climate change at normal rates (thousands of years) is not thought to have historically been a problem for sea turtle species. As explained in the *Status of the Species* sections above, sea turtles are most likely to be affected by climate change due to (1) changing air temperature and rainfall at nesting beaches, which in turn could impact nest success (hatching success and hatchling emergence rate) and sex ratios among hatchlings; (2) sea level rise, which could result in a reduction or shift in available nesting beach habitat and increased risk of nest inundation; (3) changes in the abundance and distribution of forage species, which could result in changes in the foraging behavior and distribution of sea turtle species; and (4) changes in water temperature, which could possibly lead to a northward shift in their range and changes in phenology (timing of nesting seasons, timing of migrations). Over the time period of this action considered in this Opinion, sea surface temperatures are expected to rise less than 1°C. It is unknown if that is enough of a change to contribute to shifts in the range, distribution, and recruitment of sea turtles. Theoretically, we expect that as waters in the action area warm, more sea turtles could be present or sea turtles could be present for longer periods of time.

It has been speculated that the nesting range of some sea turtle species may shift northward. Nesting in the Mid-Atlantic generally is extremely rare and no nesting has been documented at any beach in the Northeast. In 2010, one green sea turtle came up on the beach in Sea Isle City, New Jersey; however, it did not lay any eggs. In August 2011, a loggerhead came up on the beach in Stone Harbor, New Jersey, but did not lay any eggs. On August 18, 2011, a green sea turtle laid one nest at Cape Henlopen Beach in Lewes, Delaware, near the entrance to Delaware Bay. The nest contained 190 eggs and was transported indoors to an incubation facility on October 7. A total of 12 eggs hatched, with eight hatchlings surviving. In December, seven of the hatchlings were released in Cape Hatteras, North Carolina. It is important to consider that in order for nesting to be successful in the Mid-Atlantic, fall and winter temperatures need to be warm enough to support the successful rearing of eggs and sea temperatures must be warm enough for hatchlings not to die when they enter the water. The projected increase in ocean temperature over the next five years is not great enough to allow successful rearing of sea turtle eggs in the any new parts of the action area. Therefore, it is unlikely that over the time period considered here, that there would be an increase in nesting activity in the action area.

As noted above, sea level rise has the potential to remove possible beach nesting habitat. A recent study by the U.S. Geological Survey found that sea levels in a 620-mile "hot spot" along the East Coast are rising three to four times faster than the global average (Sallenger *et al.* 2012). The disproportionate sea level rise is due to the slowing of Atlantic currents caused by fresh water from the melting of the Greenland Ice Sheet. Sharp rises in sea levels from North Carolina to Massachusetts could threaten wetland and beach habitats, and negatively affect sea turtle nesting along the North Carolina coast. If warming temperatures moved favorable nesting sites northward, it is possible that rises in sea level could constrain the availability of nesting sites on existing beaches. In the next 100 years, the study predicted that sea levels will rise an additional 20-27 centimeters along the Atlantic coast "hot spot" (Sallenger *et al.* 2012).

Warming sea temperatures are likely to result in a shift in the seasonal distribution of sea turtles in the action area, such that sea turtles may begin northward migrations from their southern overwintering grounds earlier in the spring and thus would be present in the action area earlier in the year. Likewise, if water temperatures were warmer in the fall, sea turtles could remain in the action area later in the year. In the next ten years, the expected small increase in temperature is unlikely to cause a significant effect to sea turtles or a significant modification to the number of sea turtles likely to be present in the action area.

Changes in water temperature may also alter the forage base and thus, foraging behavior of sea turtles. Changes in the foraging behavior of sea turtles in the action area could lead to either an increase or decrease in the number of sea turtles in the action area, depending on whether there was an increase or decrease in the forage base and/or a seasonal shift in water temperature. For example, if there was a decrease in sea grasses in the action area resulting from increased water temperatures or other climate-change related factors, it is reasonable to expect that there may be a decrease in the number of foraging green sea turtles in the action area. Likewise, if the prey base for loggerhead, Kemp's ridley, or leatherback sea turtles was affected, there may be changes in the abundance and distribution of these species in the action area. However, as noted above, 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 changes to the foraging behavior of sea turtles over the next ten years. If sea turtle distribution shifted along with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food. Similarly, if sea turtles shifted to areas where different forage was available and sea turtles 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 sea turtles shifted to an area or time where insufficient forage was available; however, the likelihood of this happening seems low because sea turtles feed on a wide variety of species and in a wide variety of habitats. Finally, it is important to note that ocean temperature in the U.S. Northeast continental shelf and surrounding Northwest Atlantic waters have warmed faster than the global average over the last decade (Pershing *et al.* 2015). New projections for the U.S. Northeast shelf and Northwest Atlantic Ocean suggest that this region will warm two to three times faster than the global average and thus existing projections from the IPCC may be too conservative (Saba *et al.* 2015).

Shortnose and Atlantic sturgeon

Shortnose and Atlantic sturgeon have persisted for millions of years and have experienced wide variations in global climate conditions, to which they have successfully adapted. Climate change at historical rates (thousands of years) is not thought to have been a problem for sturgeon species. However, at the current rate of global climate change, future effects to sturgeon are possible. Rising sea level may result in the salt wedge moving upstream in affected rivers. Shortnose and Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile 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, at this time 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. It is unlikely that shifts in the location of the salt wedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some 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 (DO) 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.

Shortnose and Atlantic sturgeon are tolerant to water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C 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 some 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 strandings or habitat restriction. 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 sturgeon in rearing habitat.

Shortnose and Atlantic sturgeon in the action area are most likely to experience the effects of global climate change in warming water temperatures, which could change their range and migratory patterns. Warming temperatures predicted to occur over the next 100 years would likely result in a northward shift/extension of their range (i.e., into the St. Lawrence River, Canada) while truncating the southern distribution, thus affecting the recruitment and distribution of sturgeon rangewide. In the next five years, this increase in sea surface temperature is expected to be minimal, and thus, it is unlikely that this expanded range will be observed in the near future. If any shift does occur, it is likely to be minimal and thus, it seems unlikely that this small increase in temperature will cause a significant effect to shortnose and Atlantic sturgeon or a significant modification to the number of sturgeon likely to be present in the action area over the life of the proposed action. However, even a small increase in temperate can affect DO concentrations. A one degree change in temperature in Chesapeake Bay could make parts of Chesapeake Bay inaccessible to sturgeon due to decreased levels of DO (Batiuk *et al.* 2009).

Although the action area does not include spawning grounds for shortnose and Atlantic sturgeon, sturgeon are migrating through the action area to reach their natal rivers to spawn. Elevated temperatures could modify cues for spawning migration, resulting in an earlier spawning season, and thus, altering the time of year sturgeon may or may not be present within the action area. This may cause an increase or decrease in the number of sturgeon present in the action area. 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 alone will affect the seasonal movements of sturgeon through the action area.

In addition, changes in water temperature may also alter the forage base and thus, foraging behavior of sturgeon. Any forage species that are temperature-dependent may also shift in distribution as water temperatures warm and cause a shift in the distribution of sturgeon. However, because we do not know the adaptive capacity of these species 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. If 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 sturgeon shifted to an area or time where insufficient forage was available; however, the likelihood of this happening seems low because sturgeon feed on a wide variety of species and in a wide variety of habitats.

Atlantic salmon

Atlantic salmon may be especially vulnerable to the effects of climate change in watersheds that are heavily developed and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliot *et al.* 1998). Climate effects related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland 1998). Studies 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.* 2004). This shift in timing illustrates the species adaptability to changing conditions. 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).

One recent 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. 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 facing less optimal 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 (Elliot *et al.* 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

Since 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). Marine salmon growth increases in a linear trend with temperature, but eventually reaches a maximum rate and decreases at high temperatures (Brett 1979 in 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; Mills *et al*. 2013). 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 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 time frame, as small river systems tend to have lower discharges and more variable flow (Elliot *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, Elliot *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 (<23°C), 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.

As described above, over the long term, global climate change may affect Atlantic salmon by changing conditions in rivers and oceans. 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 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 Atlantic salmon, without modeling and additional scientific data, these predictions remain speculative. Additionally, these predictions do not take into account their adaptive capacity, which determines their ability to deal with change.

5.4 Reducing Threats to ESA-listed Species

5.4.1 Education and Outreach Activities

Education and outreach activities are considered some of the primary tools that will effectively reduce the threats to all protected species. For example, NMFS has been active in public outreach to educate fishermen about sea turtle handling and resuscitation techniques, and educates recreational fishermen and boaters on how to avoid interactions with marine mammals. NMFS is engaged in a number of education and outreach activities aimed specifically at increasing mariner awareness of the threat of ship strikes to large whales. NMFS also has a program called “SCUTES” (Student Collaborating to Undertake Tracking Efforts for Sturgeon), which offers educational programs and activities about the movements, behaviors, and threats to shortnose and Atlantic sturgeon. The NMFS Northeast Salmon Team spearheads education and outreach activities for Atlantic salmon through the development of conservation plans, primarily when it comes to hydropower, aquaculture, and recreational fishing projects in Maine. NMFS intends to continue these outreach efforts in an attempt to reduce interactions with protected species, and to reduce the likelihood of injury to protected species when interactions do occur.

5.4.2 Stranding and Salvage Programs

NMFS was designated the lead agency to coordinate the Marine Mammal Health and Stranding Response Program (MMHSRP), which was formalized by the 1992 Amendments to the MMPA. The program consists of state volunteer stranding networks, biomonitoring, Analytical Quality Assurance for marine mammal tissue samples, a Working Group on Marine Mammal Unusual Mortality Events (UME), and a National Marine Mammal Tissue Bank. Additionally, a serum bank and long-term storage of histopathology tissue are being developed. To respond to marine mammal strandings, volunteer stranding networks were established in all coastal states and are authorized through Letters of Authority from the NMFS regional offices. Through a National Coordinator and regional coordinators, NMFS oversees, coordinates, and authorizes these activities and provides training to personnel.

Like the MMHSRP, the NMFS-managed Sea Turtle Stranding and Salvage Network (STSSN) does not directly reduce the threats to sea turtles. However, the extensive network of STSSN participants along the Atlantic and Gulf of Mexico coasts not only collects data on dead sea turtles, but also rescues and rehabilitates live stranded turtles, reducing mortality of injured or sick animals. Data collected by the STSSN are used to monitor stranding levels, to identify areas where unusual or elevated mortality is occurring, and to identify sources of mortality. These data are also used to monitor incidence of disease, study toxicology and contaminants, and conduct genetic studies to determine population structure. All of the states that participate in the STSSN tag live turtles when encountered (either via the stranding network through incidental takes or in-water studies). Tagging studies help improve our understanding of sea turtle movements, longevity, and reproductive patterns, all of which contribute to our ability to reach recovery goals for the species.

A salvage program is also in place for shortnose and Atlantic sturgeon. Sturgeon carcasses can provide pertinent life history data and information on new or evolving threats. Their use in scientific research studies can reduce the need to collect live shortnose or Atlantic sturgeon. The NMFS Sturgeon Salvage Program is a network of individuals qualified to retrieve and/or use shortnose and Atlantic sturgeon carcasses and parts for scientific research and education. All carcasses and parts are retrieved opportunistically and participation in the network is voluntary.

5.4.3 Sea Turtle Disentanglement Network

The NMFS Greater Atlantic Region established the Northeast Sea Turtle Disentanglement Network (STDN) in 2002 in response to the high number of leatherback sea turtles found entangled in pot gear along the U.S. Northeast Atlantic coast. The STDN is considered a component of the larger STSSN program, and it operates in all states in the region. The STDN responds to entangled sea turtles and disentangles and releases live animals, thereby reducing serious injury and mortality. In addition, the STDN collects data on live and dead sea turtle entanglement events, providing valuable information for management purposes. The NMFS Greater Atlantic Regional Office oversees the STDN program and manages the STDN database.

5.4.4 Magnuson-Stevens Fishery Conservation and Management Act

There are numerous regulations mandated by the Magnuson-Stevens Fishery Conservation and Management Act that may benefit ESA-listed species. Many fisheries are subject to different time and area closures. These area closures can be seasonal or year-round. Closure areas may benefit ESA-listed species due to elimination of active gear in areas where large whales, sea turtles, and Atlantic sturgeon are present. However, if closures shift effort to areas with a comparable or higher density of ESA-listed large whales, sea turtles, or fish, then the risk of interaction could actually increase. Fishing effort reduction (i.e., landing/possession limits or trap allocations) measures may also benefit ESA-listed species by limiting the amount of time that gear is present in the species environment. Additionally, gear restrictions and modifications required for fishing regulations may also decrease the risk of entanglement with endangered species. For a complete listing of fishery regulations in the action area visit: http://www.greateratlantic.fisheries.noaa.gov/regs/info.html and http://sero.nmfs.noaa.gov/sustainable_fisheries/policy_branch/index.html.

5.4.5 Regulatory Measures for Sperm Whales

Atlantic Large Whale Take Reduction Plan

The Atlantic Large Whale Take Reduction Plan (ALWTRP) reduces the risk of serious injury to or mortality of large whales due to incidental entanglement in U.S. commercial trap/pot and gillnet fishing gear. The ALWTRP focuses on the critically endangered North Atlantic right whale, but is also intended to reduce entanglement of endangered humpback, fin, and other large whales. The plan is required by the Marine Mammal Protection Act (MMPA) and has been developed by NMFS. The ALWTRP covers the EEZ from Maine through Florida (26°46.5'N). The requirements are year-round in the Northeast, and seasonal in the Mid- and South Atlantic.

Regulatory actions are directed at reducing serious entanglement injuries and mortality of ESA-listed large whales from fixed gear fisheries (i.e., trap and gillnet fisheries). The non-regulatory component of the ALWTRP is composed of four principal parts: (1) gear research and development, (2) disentanglement, (3) the Sighting Advisory System (SAS), and (4) education/outreach. The first ALWTRP went into effect in 1997.

The regulatory component of the ALWTRP includes a combination of broad fishing gear modifications and time-area restrictions, supplemented by gear research to reduce the chance that entanglements will occur or that whales will be seriously injured or die as a result of an entanglement. The long-term goal, established by the 1994 Amendments to the MMPA, is to reduce entanglement-related serious injuries and mortalities of ESA-listed large whales to insignificant levels approaching zero within five years of its implementation.

The ALWTRP measures vary by designated area that roughly approximate the Federal Lobster Management Areas (FLMAs) designated in the federal lobster regulations. The major requirements of the ALWTRP are:

- No buoy line floating at the surface.
- No wet storage of gear (all gear must be hauled out of the water at least once every 30 days).
- Surface buoys and buoy line need to be marked to identify the vessel or fishery.
- All buoys, floatation devices and/or weights must be attached to the buoy line with a weak link. This measure is designed so that if a large whale does become entangled, it could exert enough force to break the weak link and free itself of the gear, reducing the risk of injury or mortality.
- All groundline must be made of sinking line.

In addition to the regulatory measures implemented to reduce the risk of entanglement in horizontal/groundlines, we, in collaboration with the Atlantic Large Whale Take Reduction Team (ALWTRT), have developed a strategy to further reduce risk associated with vertical lines. The actions and timeframe for the implementation of the vertical line strategy is as follows:

- Vertical line model development for all areas to gather as much information as possible regarding the distribution and density of vertical line fishing gear. Status: completed;

- Compile and analyze whale distribution and density data in a manner to overlay with vertical line density data. Status: completed;
- Development of vertical line and whale distribution co-occurrence overlays. Status: completed;
- Develop an ALWTRP monitoring plan designed to track implementation of vertical line strategy, including risk reduction. Status: completed, with annual interim reports beginning in July 2012.
- Analyze and develop potential management measures. Time frame: completed;
- Develop and publish proposed rule to implement risk reduction from vertical lines. Time frame: published on July 16, 2013.
- Develop and publish final rule to implement risk reduction from vertical lines. Time frame: first published on June 27, 2014 (79 FR 36586), with additional follow up rules published on December 12, 2014 (79 FR 73848), and May 28, 2015 (80 FR 30367).

Ship Strike Reduction Program
The Ship Strike Reduction Program is currently focused on protecting the North Atlantic right whale, but the operational measures are expected to reduce the incidence of ship strike on other large whales to some degree. The program consists of five basic elements and includes both regulatory and non-regulatory components: 1) operational measures for the shipping industry, including speed restrictions and routing measures, 2) section 7 consultations with Federal agencies that maintain vessel fleets, 3) education and outreach programs, 4) a bilateral conservation agreement with Canada, and 5) continuation of ongoing measures to reduce ship strikes of right whales (e.g., SAS, ongoing research into the factors that contribute to ships trikes, and research to identify new technologies that can help mariners and whales avoid each other).

Vessel Speed Restrictions
A key component of NOAA's ship strike reduction program is the implementation of speed restrictions for vessels transiting the U.S. Atlantic in areas and seasons where large whales predictably occur in high concentrations. The Northeast Implementation Team (NEIT)-funded report "Recommended Measures to Reduce Ship Strikes of North Atlantic Right Whales" found that seasonal speed and routing measures could be an effective means of reducing the risk of ship strike along the U.S. East Coast. Based on these recommendations, NMFS published an Advance Notice of Proposed Rulemaking (ANPR) in June 2004 (69 FR 30857; June 1, 2004), and subsequently published a proposed rule on June 26, 2006 (71 FR 36299; June 26, 2006). We published regulations on October 10, 2008 to implement a 10-knot speed restriction for all vessels 19.8 meters (65 feet) or longer in Seasonal Management Areas (SMAs) along the East Coast of the U.S. Atlantic seaboard, including the action area, at certain times of the year (73 FR 60173; October 10, 2008).

SMAs are supplemented by Dynamic Management Areas (DMAs) that are implemented for 15 day periods in areas in which right whales are sighted outside of SMA boundaries. DMAs can be designated anywhere along the U.S. eastern seaboard, including the action area, when NOAA aerial surveys or other reliable sources report aggregations of three or more right whales in a density that indicates the whales are likely to persist in the area. When DMAs are designated, NOAA calculates a buffer zone around the aggregation and announces the boundaries of the zone to mariners via various mariner communication outlets, including NOAA Weather Radio, USCG Broadcast Notice to Mariners, MSR return messages, email distribution lists, and the Right Whale Sighting Advisory System (SAS). NOAA requests mariners route around these zones or transit through them at 10knots or less. Compliance with these zones is voluntary.

On December 9, 2013, we issued a final rule to eliminate the expiration date (or "sunset clause") contained in regulations requiring vessel speed restrictions to reduce the likelihood of lethal vessel collisions with North Atlantic right whales (78 FR73726).

Marine Mammal Health and Stranding Response Program (MMHSRP)
Marine mammals can strand anywhere along the eastern seaboard of the U.S. In response to this fact, we were designated the lead agency to coordinate the MMHSRP which was formalized by the 1992 Amendments to the MMPA. The program consists of the following components, all of which contribute important information on endangered large whales through stranding response and data collection:

- All coastal states established volunteer stranding networks and are authorized through Letters of Authority from NMFS regional offices to respond to marine mammal strandings.

- Biomonitoring to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains and marine ecosystem health.

- The Analytical Quality Assurance (AQA) was designed to ensure accuracy, precision, level or detection, and intercomparability of data in the chemical analyses of marine mammal tissue samples.

- NMFS established a Working Group on Marine Mammal Unusual Mortality Events to provide criteria to determine when a UME is occurring and how to direct responses to such events. The group meets annually to discuss many issues including recent mortality events involving endangered species both in the United States and abroad.

- The National Marine Mammal Tissue Bank provides protocols and techniques for the long-term storage of tissues from marine mammals for retrospective contaminant analyses. Additionally, a serum bank and long-term storage of histopathology tissue are being developed.

5.4.6 Regulatory Measures for Sea Turtles

Numerous efforts are ongoing to reduce threats to listed sea turtles. Below, we detail efforts that are ongoing within the action area. The majority of these activities are related to regulations that have been implemented to reduce the potential for incidental mortality of sea turtles from commercial fisheries. These include sea turtle release gear requirements for Atlantic HMS; TED requirements for Southeast shrimp trawl fishery and the southern part of the summer flounder trawl fishery; mesh size restrictions in the North Carolina gillnet fishery and Virginia's gillnet and pound net fisheries; modified leader requirements in the Virginia Chesapeake Bay pound net fishery; area closures in the North Carolina gillnet fishery; and gear modifications in the Atlantic sea scallop dredge fishery. The summaries below discuss all of these measures in more detail.

Large Mesh Gillnet Requirements in the Mid-Atlantic
In March 2002, NMFS published new restrictions for the use of gillnets with larger than 8-inch (20.3 cm) stretched mesh, in Federal waters (3-200 nautical miles) off of North Carolina and Virginia. These restrictions were published in an interim final rule under the authority of the ESA (67 FR 13098) and were implemented to reduce the impact of the monkfish and other large-mesh gillnet fisheries on ESA-listed sea turtles in areas where sea turtles are known to concentrate. Following review of public comments submitted on the interim final rule, NMFS published a final rule on December 3, 2002, that established the restrictions on an annual basis. As a result, gillnets with larger than 8-inch (20.3 cm) stretched mesh are not allowed in Federal waters (3-200 nautical miles) in the areas described as follows: (1) North of the North Carolina/South Carolina border at the coast to Oregon Inlet at all times; (2) north of Oregon Inlet to Currituck Beach Light, NC from March 16 through January 14; (3) north of Currituck Beach Light, NC, to Wachapreague Inlet, VA, from April 1 through January 14; and (4) north of Wachapreague Inlet, VA, to Chincoteague, VA, from April 16 through January 14. On April 26, 2006, NMFS published a final rule (71 FR 24776) that included modifications to the large-mesh gillnet restrictions. The new final rule revised the gillnet restrictions to apply to stretched mesh that is ≥7 inches (17.9 cm). Federal waters north of Chincoteague, VA, remain unaffected by the large-mesh gillnet restrictions. These measures are in addition to the HPTRP measures that prohibit the use of large-mesh gillnets in southern Mid-Atlantic waters (territorial and Federal waters from Delaware through North Carolina out to 72°30'W longitude) from February 15 through March 15, annually. The measures are also in addition to comparable North Carolina and Virginia regulations for large-mesh gillnet fisheries in their respective state waters that were enacted in 2005.

NMFS has also issued a rule addressing capture of sea turtles in gillnet gear fished in the southern flounder fishery in Pamlico Sound. NMFS issued a final rule (67 FR 56931), effective September 3, 2002, that closed the waters of Pamlico Sound, NC, to fishing with gillnets with larger than 4 ¼-inch (10.8 cm) stretched mesh from September 1 through December 15 each year to protect migrating sea turtles. The closed area includes all inshore waters of Pamlico Sound south of 35°46.3'N latitude, north of 35°00'N latitude, and east of 76°30'W longitude.

Revised Use of TEDs for U.S. Southeast Shrimp Trawl Fisheries
On February 21, 2003, NMFS issued a final rule (68 FR 8456) to amend regulations for reducing sea turtle mortality resulting from shrimp trawling in the Atlantic and Gulf areas of the southeastern U.S. TEDs have proven to be effective at excluding sea turtles from shrimp trawls. However, NMFS determined that modifications to the design of TEDs needed to be made to exclude leatherbacks, as well as large, benthic, immature and sexually mature loggerhead and green sea turtles. In addition, several previously approved TED designs did not function properly under normal fishing conditions. Therefore, NMFS disallowed these TEDs (e.g., weedless TEDs, Jones TEDs, hooped hard TED, and the use of accelerator funnels) as described in the final rule. Finally, the rule also required modifications to the trynet and bait shrimp exemptions to the TED requirements to decrease mortality of sea turtles.

In 1993 (with a final rule implemented in 1995), NMFS established a Leatherback Conservation Zone to restrict shrimp trawl activities from the coast of Cape Canaveral, Florida, to the North Carolina/Virginia border. This provided for short-term closures when high concentrations of normally pelagically distributed leatherbacks are recorded in near coastal waters where the shrimp fleet operates. This measure was necessary because, due to their size, adult leatherbacks were larger than the escape openings of most NMFS-approved TEDs. With the implementation of the new TED rule requiring larger opening sizes on all TEDs, the reactive emergency closures within the Leatherback Conservation Zone became unnecessary, and the Leatherback Conservation Zone was removed from the regulations.

TED Requirements for the Summer Flounder Fishery
As mentioned above, significant measures have been developed to reduce the incidental take of sea turtles in summer flounder trawls and trawls that meet the definition of a summer flounder trawl (which would include fisheries for other species like scup and black sea bass) by requiring TEDs in trawl nets fished in trawls used in the area of greatest turtle bycatch off the North Carolina and part of the Virginia coast from North Carolina/South Carolina border to Cape Charles, Virginia. The TED requirements for the summer flounder trawl fishery do not, however, require the use of larger TEDs that are required to be used in the U.S. Southeast shrimp trawl fisheries.

Modification of Gear for Virginia Pound Nets
Existing information indicates that pound nets with traditional large mesh and stringer leaders, as used in the Chesapeake Bay, incidentally take sea turtles. NMFS published a temporary rule in June 2001 (66 FR 33489) that prohibited fishing with pound net leaders with a mesh size measuring 8-inches (20.3 cm) or greater, and pound net leaders with stringers in mainstream waters of the Chesapeake Bay and its tributaries for a 30-day period beginning June 19, 2001. NMFS subsequently published an interim final rule in 2002 (67 FR 41196, June 17, 2002) that further addressed the take of sea turtles in large-mesh pound net leaders and stringer leaders used in the Chesapeake Bay and its tributaries. Following new observations of sea turtle entanglements in pound net leaders in the spring of 2003, NMFS issued a temporary final rule (68 FR 41942, July 16, 2003) that restricted all pound net leaders throughout Virginia’s waters of the Chesapeake Bay and a portion of its tributaries from July 16 - July 30, 2003.

A new final rule was published May 5, 2004 (69 FR 24997) to address sea turtle entanglements with pound net gear that might occur in the Chesapeake Bay during the period May 6 - July 15 each year. That rule prohibited the use of all pound net leaders, set with the inland end of the leader greater than 10 horizontal feet (3 meters) from the mean low water line, from May 6 - July 15 each year in the Virginia waters of the mainstream Chesapeake Bay, south of 37°19’N and west of 76°13’W, and all waters south of 37°13’N to the Chesapeake Bay Bridge Tunnel at the mouth of the Chesapeake Bay, and the James and York Rivers downstream of the first bridge in each tributary. Outside of this area, the prohibition of leaders with greater than or equal to 12 inches (30.5 cm) stretched mesh and leaders with stringers, as established by the June 17, 2002, interim final rule, applied from May 6 - July 15 each year.

In response to new information acquired through gear research, on April 17, 2006, NMFS published a proposed rule in the *Federal Register* that would allow the use of offshore pound net leaders meeting the definition of a *modified pound net leader* in a portion of the Chesapeake Bay during the period May 6 to July 15 each year. Modifications to the pound net leader address: (1) the maximum allowed mesh size; (2) placement of the leader in relation to the sea floor; (3) the height of the mesh from the sea floor in relation to the depth at mean lower low water; and (4) the use of vertical lines to hold the mesh in place. Following review of public comments received on the proposed rule, NMFS published a final rule implementing the action on June 23, 2006 (71 FR 36024).

On February 9, 2015, NMFS published a final rule in the *Federal Register* to amend the Bottlenose Dolphin Take Reduction Plan and its implementing regulations under the MMPA and the sea turtle conservation regulations under the ESA as they relate to Virginia pound nets (80 FR 6925). The rule became effective on March 11, 2015, and required the year-round use of modified pound net leaders for offshore Virginia pound nets in specified waters of the lower mainstem Chesapeake Bay and coastal state waters under the MMPA. Under both the MMPA and ESA, the final rule also included a one-time compliance training for modified leaders, new and revised Virginia pound net-related definitions, and requirements to fish all sections of the gear at the same time. This most recent rulemaking has provided additional protective measures for sea turtles.

HMS Sea Turtle Protection Measures

NMFS completed the most recent biological opinion on the FMP for the Atlantic HMS fisheries for tuna and swordfish on June 1, 2004, and concluded that the pelagic longline component of the fishery was likely to jeopardize the continued existence of leatherback sea turtles. An RPA was provided to avoid jeopardy to leatherback sea turtles as a result of the operation of this component of the fishery. The RPA was also expected to benefit loggerhead sea turtles by reducing the likelihood of mortality resulting from interactions with the gear. Regulatory components of the RPA have been implemented through rulemaking. Since 2004, bycatch estimates for loggerheads and leatherbacks in pelagic longline gear have been well below the average prior to implementation of gear regulations under the RPA (Garrison and Stokes 2014).

Modified Scallop Dredge Gear in the Mid-Atlantic Sea Scallop Fishery

To reduce serious injury and mortality to sea turtles resulting from capture in the sea scallop dredge bag, NMFS has required the use of a chain-mat modified dredge in the Atlantic sea scallop fishery since 2006 (71 FR 50361, August 25, 2006; 71 FR 66466, November 15, 2006; 73 FR 18984, April 8, 2008; 74 FR 20667, May 5, 2009). Federally permitted scallop vessels south of 41°09'N from the shoreline to the outer boundary of the EEZ are required to modify their dredge gear by adding an arrangement of horizontal and vertical chains (a "chain mat") over the opening of the dredge bag from of May 1 through November 30 each year. This modification is not expected to reduce the overall number of sea turtle interactions with gear. However, it is expected to reduce the severity of the interactions.

Since May 1, 2013, all limited access scallop vessels, as well as Limited Access General Category vessels with a dredge width of 10.5 feet or greater, have been required to use a Turtle Deflector Dredge (TDD) in the Mid-Atlantic (west of 71°W) from May 1 through October 31 each year (77 FR 20728, April 6, 2012). The purpose of the TDD requirement is to deflect sea turtles over the dredge frame and bag rather than under the cutting bar, so as to reduce sea turtle injuries due to contact with the dredge frame on the ocean bottom (including being crushed under the dredge frame). The TDD has specific components that are defined in the regulations. When combined with the effects of chain mats, which decrease captures in the dredge bag, the TDD should provide greater sea turtle benefits by reducing serious injury and mortality due to interactions with the dredge frame, compared to a standard New Bedford dredge.

To eliminate confusion, the seasons and areas for these two gear measures designed to protect sea turtles were later aligned through the final rule for Framework 26 to the Atlantic Sea Scallop FMP (80 FR 22119; April 21, 2015). Following the enactment of the final rule, sea turtle chain mats and TDDs are now required west of 71°W longitude from May through November.

Sea Turtle Handling and Resuscitation Techniques
NMFS has developed and published as a final rule in the *Federal Register* (66 FR 67495; December 31, 2001) sea turtle handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the final rule. These measures help to prevent mortality of hard-shelled turtles caught in fishing or scientific research gear.

Sea Turtle Entanglements and Rehabilitation
A final rule (70 FR 42508) published on July 25, 2005, allows any agent or employee of NMFS, the USFWS, the U.S. Coast Guard, or any other Federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA (50 CFR 223.206(b)).

5.4.7 Regulatory Measures for Shortnose and Atlantic Sturgeon

Sturgeon Recovery Planning
Several conservation actions aimed at reducing threats to shortnose and Atlantic sturgeon are currently ongoing. The most recent recovery plan for shortnose sturgeon was written by NMFS back in 1998. In the near future, NMFS will be convening a recovery team and drafting a recovery plan which will outline recovery goals and criteria and steps necessary to recover all Atlantic sturgeon DPSs. Numerous research activities are underway for both sturgeon species, involving NMFS and other Federal, State, and academic partners, to obtain more information on the distribution and abundance of sturgeon throughout their range, including in the action area. Efforts are also underway to better understand threats faced by sturgeon and ways to minimize these threats, including bycatch and water quality. Fishing gear research is underway to design fishing gear that minimizes interactions with Atlantic sturgeon while maximizing retention of targeted fish species. Several states are in the process of preparing ESA section 10 Habitat Conservation Plans aimed at minimizing the effects of state fisheries on Atlantic sturgeon.

Research Activity Guidelines

Research activities aid in the conservation of listed species by furthering our understanding of the species' life history and biological requirements. We recognize, however, that many scientific research activities involve capture and may pose some level of risk to individuals or to the species. Therefore, it is necessary for research activities to be carried out in a manner that minimizes the adverse impacts of the activities on individuals and the species while obtaining crucial information that will benefit the species. Guidelines developed by sturgeon researchers in cooperation with NMFS staff (Moser *et al.* 2000; Damon-Randall *et al.* 2010; Kahn and Mohead 2010) provide standardized research protocols that minimize the risk to sturgeon species from capture, handling, and sampling. These guidelines must be followed by any entity receiving a federal permit to do research on shortnose or Atlantic sturgeon.

Protections for the GOM DPS of Atlantic Sturgeon

The prohibitions listed under section 9(a)(1) of the ESA automatically apply when a species is listed as endangered but not when listed as threatened. When a species is listed as threatened, section 4(d) of the ESA requires the Secretary of Commerce (Secretary) to issue regulations, as deemed necessary and advisable, to provide for the conservation of the species. The Secretary may, with respect to any threatened species, issue regulations that prohibit any act covered under section 9(a)(1). Whether section 9(a)(1) prohibitions are necessary and advisable for a threatened species is largely dependent on the biological status of the species and the potential impacts of various activities on the species. On June 10, 2011, we proposed protective measures for the GOM DPS of Atlantic sturgeon (76 FR 34023). On November 19, 2013 we published a preliminary final rule that applied all prohibitions of section 9(a)(1) to the GOM DPS beginning on December 19, 2013 (78 FR 69310).

Proposed Rules Designating Critical Habitat for Atlantic Sturgeon DPSs

On June 3, 2016, NMFS issued two proposed rules to designate critical habitat for the five listed DPSs of Atlantic sturgeon found in U.S. waters (Gulf of Maine, New York Bight, and Chesapeake Bay DPSs: 81 FR 35701; Carolina and South Atlantic DPSs: 81 FR 36078). The specific areas proposed for designation include approximately 244 kilometers (152 miles) of aquatic habitat in rivers in Maine, New Hampshire, and Massachusetts for the Gulf of Maine DPS; approximately 547 kilometers (340 miles) of aquatic habitat in rivers in Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, and Delaware for the New York Bight DPS; and approximately 729 kilometers (453 miles) of aquatic habitat in rivers in Maryland, Virginia, and the District of Columbia for the Chesapeake Bay DPS (81 FR 35701).

Specific occupied areas proposed for designation as critical habitat for the Carolina DPS of Atlantic sturgeon contain approximately 1,997 kilometers (1,241 miles) of aquatic habitat within the following rivers: Roanoke, Tar-Pamlico, Neuse, Cape Fear, Northeast Cape Fear, Waccamaw, Pee Dee, Black, Santee, North Santee, South Santee, and Cooper, and the following other water body: Bull Creek. In addition, NMFS proposes to designate unoccupied areas for the Carolina DPS totaling 383 kilometers (238 miles) of aquatic habitat within the Cape Fear, Santee, Wateree, Congaree, and Broad Rivers, and within Lake Marion, Lake Moultrie, rediversion canal, and diversion canal. Specific occupied areas proposed for designation as critical habitat for the South Atlantic DPS of Atlantic sturgeon contain approximately 2,911 kilometers (1,809 miles) of aquatic habitat within the Edisto, Combahee-Salkehatchie, Savannah, Ogeechee, Altamaha, Ocmulgee, Oconee, Satilla, and St. Marys Rivers. In addition, NMFS proposes to designate an unoccupied area within the Savannah River for the South Atlantic DPS that contains 33 kilometers (21 miles) of aquatic habitat (81 FR 36078).

NMFS is soliciting comments from the public on all aspects of the proposals, including information on the economic, national security, and other relevant impacts of the proposed designations, as well as the benefits to the DPSs. Comments on these proposed rules must be received by September 1, 2016.

5.4.8 Regulatory Measures for Atlantic Salmon

NMFS has worked with the Maine Department of Marine Resources, USFWS, the Penobscot Indian Nation, and other partners to pursue a range of management and research activities to mitigate and reduce the most severe threats to Atlantic salmon and to improve understanding of salmon abundance and population health. Recovery actions and activities recently implemented include: (1) conducting reviews of Species Protection Plans for FERC-licensed hydroelectric projects in the Gulf of Maine DPS; (2) developing fish passage guidelines; (3) developing a quantitative model to assess the impacts of proposed dam-related work; (4) completing a survey of non-power generating dams and their effect on Atlantic salmon habitat that resulted in multiple dam removals; (5) developing a General Conservation Plan with operating conditions for non-power generating dam owners who request incidental take permits; and (6) consulting with Federal partners to assure that Federal actions minimize harm to Atlantic salmon.

International Coordination and Collaboration to Protect Atlantic Salmon
NMFS participates in the North Atlantic Salmon Conservation Organization (NASCO), the international governing body that jointly manages Atlantic salmon. Participation in NASCO has led to the development of multi-year regulatory measures for high-seas Atlantic salmon fisheries, international guidelines for salmon stocking and mitigation of threats from aquaculture practices, and country specific Action Plans that outline the implementation of all the NASCO guidelines.

International Atlantic Salmon Research
NMFS works with international partners to conduct annual sampling of the Atlantic salmon fishery in West Greenland. From this sampling, biological information related to the Greenlandic local-use catch is used to confirm catch, support international Atlantic salmon stock assessments, and determine salmon continent-of-origin while providing a platform for research evaluating the ecological health of Atlantic salmon at Greenland.

Restoring Ecosystem Function for Atlantic Salmon
NMFS, the Maine Department of Marine Resources, USFWS, and other partners have taken a number of steps to restore ecosystem function as part of the Atlantic Salmon Recovery Plan. Among these are dam removals, including the recent removals of the Great Works and Veazie Dams on the Penobscot River. Removal of these two dams allows Atlantic salmon and other diadromous unimpeded access to sections of the Penobscot River that they have not had in 200 years. Several small projects such as bypasses, fishways, culvert replacements, and barrier (including dams) removal helped restore physical and biological features necessary to further

salmon recovery in the Gulf of Maine DPS. In addition, active stocking and fisheries management is supporting recovery of other diadromous species.

Atlantic Salmon Annual Assessment and Monitoring
NMFS supports several annual assessment and monitoring efforts to gain greater understanding of Atlantic salmon movement patterns and community. This information will help inform future management decisions. Among these efforts are: (1) a satellite-tagging project of adult Atlantic salmon off the coast of West Greenland to track ocean movements; (2) a fish community study in the Penobscot River estuary; and (3) telemetry studies measuring Atlantic salmon smolt survival from the Penobscot River to the Gulf of Maine and monitoring fish at Halifax, Nova Scotia.

6.0 EFFECTS OF THE ACTIONS

As discussed in the *Description of the Proposed Actions*, the proposed actions are fisheries and ecosystem research activities conducted and funded by the NEFSC in the action area. This consultation considers long-term survey programs as well as short-term cooperative research projects to be carried out over the next five years. Sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon may be affected by the proposed actions in a number of ways. This includes via: (1) direct capture, hooking, or entanglement in fishing gear; (2) interactions with research and fishing vessels; (3) effects to prey; (4) effects to habitat; and (5) effects (i.e., harassment) from active acoustics sources. The following effects analysis will be organized along these topics.

In regards to calculating adverse impacts to ESA-listed species (or incidental takes), Chapter 4 of the December 2014 DPEA contains data and information on past and anticipated interactions of sea turtles and Atlantic sturgeon with the gears utilized by the NEFSC and its research partners under the Preferred Alternative. The authors of that section are subject matter experts who developed a discussion of the effects on these species based on their best professional judgment, relying on the collective knowledge of other specialists in their respective fields and the body of accepted literature (NEFSC 2014). For sperm whales, the NMFS OPR conducted their own analysis of the anticipated number acoustic harassment events from active sources based on sperm whale densities in offshore areas where active sources are likely to be used. For shortnose sturgeon and Atlantic salmon, the GARFO PRD estimated takes based on past interactions recorded during NEFSC conducted or funded studies, as well as similar types of research studies or fishing activities using similar gears in parts of the action area where future fisheries and ecosystem research was anticipated.

6.1 Effects to Sperm Whales

The two predominant active acoustic source types to be used during NEFSC conducted or funded research over a five-year period, and which are likely to result in adverse effects to sperm whales, include the following:

1. **Simrad EK60:** A narrow bean echosounder system which transmits at six frequencies ranging from 18 to 333 kHz. Primary frequencies are: 38, 70, 120, and 200 kilohertz (kHz).

- Assumptions: Sperm whales are likely to receive signals at 38, 70, and 120 kHz. Thus, they are likely to perceive 75% of the EK60 signals originally analyzed for the proposed rule and application.

2. **Simrad ME70:** A multibeam echosounder which transmits at frequencies from 70 to 120 kHz.
   - Assumptions: Sperm whales are likely to receive all of the signals at 70 and 120 kHz. Thus, they are likely to perceive 100% of the signals originally analyzed for the proposed rule and application.

The NEFSC has not requested, and the OPR does not propose, to authorize serious injuries/ mortalities (Level A take) for any ESA-listed species within the action area. However, they propose to authorize harassment (Level B take) incidental to the NEFSC's use of active acoustic sources for sperm whales. As shown in Table 13, which will be included in the pending LOA final rule, the proposed authorized take represents 15 incidents (12 due to use of the Simrad EK60, three due to use of the Simrad ME70) where an individual sperm whale could be exposed to Level B harassing sound frequencies if occurring in the near vicinity of a fishery research vessel using these sound sources. These incidents of take are based upon the volumetric densities of sperm whales throughout the action area (as calculated by the NEFSC) and the ability to perceive frequencies at which the two predominant acoustic sources resulting in acoustic harassment will operate (as determined by the OPR's Permits and Conservation Division).

Table 13. Active acoustic sources resulting in Level B harassment to be used by the NEFSC. Take estimates reflect considerations of functional hearing in relation to the specific sources.

Species	Simrad EK60	
	38, 70, 120, and 200 kHz	
	Proposed Rule	**Final Rule**
North Atlantic right whale	2	0
Humpback whale	1	0
Sei whale	3	0
Fin whale	4	0
Blue whale	1	0
Sperm whale	16	12

Species	Simrad ME70	
	70 to 120 kHz	
	Proposed Rule	**Final Rule**
North Atlantic right whale	7	0
Humpback whale	3	0
Sei whale	10	0
Fin whale	13	0
Blue whale	1	0
Sperm whale	3	3

Using area of ensonification and volumetric density to estimate exposures
Estimates of potential incidents of Level B harassment for sperm whales (i.e., potential exposure to levels of sound at or exceeding the 160 dB rms threshold) were calculated for offshore areas of the Atlantic coast region by using: (1) the combined results from output characteristics of each source and identification of the predominant sources in terms of acoustic output (Tables 2 and 12 of the LOA proposed rule); (2) their relative annual usage patterns for each depth stratum (Tables 13, 14, and 15 of the proposed rule); (3) a source-specific determination made of the area of water associated with received sounds at either the extent of a depth boundary or the 160 dB rms received sound level; and (4) determination of a biologically-relevant volumetric density of sperm whales in each area (Table 16 of the proposed rule). Estimates of Level B harassment by acoustic sources are the product of the volume of water ensonified at 160 dB rms or higher for the predominant sound source for each portion of the total line-kilometers for which it is used and the volumetric density of sperm whales. For the species and sound source, the cross sectional area for the relevant depth strata (Tables 13, 14, and 15 of the proposed rule) was multiplied by the effective line-kilometers for each respective depth strata for the relevant survey area and the volumetric density to estimate Level B harassment (80 FR 39542).

To get to the 12 incidents of sperm whale take as a result of the Simrad EK60, the OPR multiplied the effective exposure area (offshore) [11] from Table 12 of the LOA proposed rule (0.1411 km^2) by the effective total survey line-kilometers (offshore) from Table 15 of the proposed rule (3,666 km), and then multiplied that value by the sperm whale volumetric density (offshore) from Table 16 of the proposed rule (0.0304 animals/km^3).

- 0.1411 km^2 x 3,666 km x 0.0304 animals/km^3 = 16 animals

They then multiplied the above value by 75%, as sperm whales are likely to perceive 75% of the Simrad EK60 signals analyzed for the proposed rule and application, which equates to 12.

To get to the three incidents of sperm whale take as a result of the Simrad ME70, the OPR multiplied the effective exposure area (offshore) from Table 12 of the LOA proposed rule (0.0201 km^2) by the effective total survey line-kilometers (offshore) from Table 15 of the proposed rule (5,150 km), and then multiplied that value by the sperm whale volumetric density (offshore) from Table 16 of the proposed rule (0.0304 animals/km^3).

- 0.0201 km^2 x 5,150 km x 0.0304 animals/km^3 = three animals

They then multiplied the above value by 100%, as sperm whales are likely to perceive 100% of the Simrad ME70 signals analyzed for the proposed rule and application, which equates to three.

6.2 Effects to Sea Turtles

As described in sections 4.2.2.1 - 4.2.2.4, the occurrence of loggerhead, Kemp's ridley, green, and leatherback sea turtles in New England, Mid-Atlantic, and south Atlantic waters is primarily temperature dependent (Thompson 1984; Keinath *et al.* 1987; Shoop and Kenney 1992; Musick and Limpus 1997; Morreale and Standora 1998, 2005; Mitchell *et al.* 2003; Braun-McNeill and

[11] Effective exposure area: sea surface to depth at which 160-dB threshold is reached (km^2)

Epperly 2004; James *et al.* 2005a). In general, sea turtles move up the U.S. Atlantic coast from southern wintering areas as water temperatures warm in the spring (Keinath *et al.* 1987; Shoop and Kenney 1992; Musick and Limpus 1997; Morreale and Standora 1998, 2005; Mitchell *et al.* 2003; Braun-McNeill and Epperly 2004; James *et al.* 2005a). The trend is reversed in the fall as water temperatures cool. By December, sea turtles have passed Cape Hatteras, returning to more southern waters for the winter (Keinath *et al.* 1987; Shoop and Kenney 1992; Musick and Limpus 1997; Morreale and Standora 1998, 2005; Mitchell *et al.* 2003; Braun-McNeill and Epperly 2004; James *et al.* 2005a). Recreational anglers have reported sightings of sea turtles in waters defined as inshore waters (bays, inlets, rivers, or sounds; Braun-McNeill and Epperly 2004) as far north as New York as early as March-April, but in relatively low numbers (Braun-McNeill and Epperly 2004). Greater numbers of loggerheads, Kemp's ridleys, and greens are found in inshore, nearshore, and offshore waters of North Carolina and Virginia from May through November and in inshore, nearshore, and offshore waters of New York from June through October (Keinath *et al.* 1987; Morreale and Standora 1993; Braun-McNeill and Epperly 2004). The hard-shelled sea turtles (loggerheads, Kemp's ridleys, and greens) appear to be temperature limited to water no further north than Cape Cod. Leatherback sea turtles have a similar seasonal distribution but have a more extensive range in the Gulf of Maine compared to the hard-shelled species (Shoop and Kenney 1992; Mitchell *et al.* 2003; STSSN database).

Extensive survey effort of the continental shelf from Cape Hatteras to Nova Scotia, Canada in the 1980s (CeTAP 1982) revealed that loggerheads were observed at the surface in waters from the beach to waters with bottom depths of up to 4,481 meters. However, they were generally found in waters where bottom depths ranged from 22-49 meters deep (the median value was 36.6 meters; Shoop and Kenney 1992). Leatherbacks were sighted at the surface in waters with bottom depths ranging from 1-4,151 meters deep (Shoop and Kenney 1992). However, 84.4% of leatherback sightings occurred in waters where the bottom depth was less than 180 meters (Shoop and Kenney 1992), whereas 84.5% of loggerhead sightings occurred in waters where the bottom depth was less than 80 meters (Shoop and Kenney 1992). Neither species was commonly found in waters over Georges Bank, regardless of season (Shoop and Kenney 1992). The CeTAP study did not include Kemp's ridley and green sea turtle sightings, given the difficulty of sighting these smaller sea turtle species (CeTAP 1982).

The Southeast Turtle Survey (SeTS), an aerial survey research program initiated by the SEFSC in 1982 through 1984, was conducted from Cape Hatteras to Key West over coastal waters from the coastline to the approximate mean western boundary of the Gulf Stream (Thompson 1984). Seasonal surveys that corresponded to spring (April-May) and summer (July-August) were completed in all three years. Fall (October-November) surveys were completed in 1982 and 1983 and a single winter survey was completed in January/February 1983 (Thompson and Huang 1993). The study area was designed as a southern extension of the CeTAP aerial surveys. These surveys showed that sea turtles in the south Atlantic region are distributed randomly from the coast out to the Gulf Stream except in the winter. During the winter, sea turtles appear to aggregate within the western Gulf Stream boundary waters which can be 5°-6°C warmer than coastal waters (Thompson 1988).

Given the seasonal occurrence patterns and water depth preferences of sea turtles off the U.S. Atlantic coast from Florida to New England, the distribution of sea turtles is likely to overlap with most of the fisheries and ecosystem studies to be conducted by the NEFSC under the proposed actions. This is confirmed by the past capture of sea turtles during the NEFSC and NEAMAP research vessel surveys as well as in numerous commercial fisheries using similar gear types (trawls, gillnets, dredges, hook and line) as evidenced by NEFOP incidental take data.

Direct and indirect effects of NEFSC research activities on sea turtles may include: disturbances or changes in sea turtle behavior due to physical movements and sounds, injury or mortality due to vessel strikes, capture/hooking/entanglement in gear, and contamination or degradation of sea turtle habitat. Historical takes of sea turtles during the NEFSC's fisheries and ecosystem research projects from 2004-2013 are presented in Table 4.2-14 of the 2014 DPEA. Incidental captures of all four species have been documented, and have occurred in nearly equal numbers between the NE (36) and SE (39) LMEs. Sea turtles have only been caught in the following four long-term NEFSC-affiliated survey programs: (1) Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) gillnet and longline surveys, (2) Spring and Fall NEFSC Standard Bottom Trawl Surveys (BTS), (3) Spring and Fall NEAMAP trawl surveys, and (4) Apex Predators longline surveys. Table 14 provides quantitative estimates of sea turtle captures and mortalities under the proposed actions, including the four major recurring surveys noted above as well as other short-term cooperative research projects, based on gear types used and deployment details such as tow times and soak durations. The risk analysis is organized by gear type as described below.

Table 14. Estimated Future Takes of Sea Turtles under the NEFSC's Proposed Actions

Gear type	Trawl		Longline		Gillnet		Totals	
Species	Captures per year	SI&M per year	Captures per year	SI&M per year	Captures per year	SI&M per year	Captures per year	SI&M per year
Loggerhead	(14.7) 15 turtles	(0.19) 1 turtle	(1.6) 2 turtles	(0.16) 1 turtle	0	0	17 turtles	2 turtles
Kemp's ridley	(13.1) 14 turtles	(0.2) 1 turtle	(1.9) 2 turtles	(0.19) 1 turtle	(2.8) 3 turtles	(0.41) 1 turtle	19 turtles	3 turtles
Green	(0.1) 1 turtle	0	0	0	(0.4) 1 turtle	0	2 turtles	0
Leatherback	(0.1) 1 turtle	0	(0.6) 1 turtle	(0.06) 1 turtle	0	0	2 turtles	1 turtle
Totals	31 turtles	2 turtles	5 turtles	3 turtles	4 turtles	1 turtle	40 turtles	6 turtles

*Numbers of estimated captures/hookings/entanglements and serious injuries/mortalities (SI&M) totaled from Table 4.3-4 of the DPEA (in parentheses), rounded up to the next highest whole number of sea turtles.

Captures and Mortality in Trawl Gear

The proposed actions include the addition of two research activities that use mid-water (pelagic) trawl gear: the NEFOP mid-water trawl training cruises and the Northeast Integrated Pelagic Survey. Although there is a slight risk of interactions with pelagic foraging juveniles of hard-shelled species and leatherback sea turtles, these gear types have not been the subject of as much conservation concern for sea turtles as bottom trawl fisheries, and we do not anticipate any adverse interactions of sea turtles with this type of gear (NMFS 2012b).

The estimated trawl effort for future fisheries and ecosystem research projects is expected to involve more trawls, and many of these trawls are expected to be of short duration (i.e., 20 to 30 minutes), which greatly reduces the risk of mortality from forced submersion. Short-term conservation engineering projects usually involve protocols closer to commercial fishing conditions so these projects have been separated out to account for longer tow times (assuming an average of 60 minutes per tow) and associated higher serious injury/mortality rates.

Table 14 provides the number of estimated captures and serious injuries/mortalities for all NEFSC-affiliated trawl projects that are likely to interact with sea turtles, rounded up to next highest whole number of turtles. Most of the estimated captures and all of the serious injuries and mortalities are associated with short-term cooperative research surveys due to greater overall trawl effort and longer tow times for some projects. For all NEFSC-affiliated research trawls:

- Up to 15 loggerhead sea turtles may be captured per year and one of those takes may be lethal;
- Up to 14 Kemp's ridley sea turtles may be captured per year and one of those takes may be lethal; and
- Up to one each of green and leatherback sea turtles may be captured per year with a remote chance of mortalities.

<u>Captures and Mortality in Longline Gear</u>

The proposed actions include one additional project involving longline gear, the NEFOP longline training cruises. This project would involve commercial fishing vessels and gear but would make longline sets of much shorter duration than typical in commercial fisheries. The addition of these limited number of longline sets would incrementally increase the risk of capturing sea turtles. Table 14 provides the number of estimated captures and serious injuries/mortalities for all NEFSC-affiliated longline projects that are likely to interact with sea turtles, rounded up to next highest whole number of sea turtles. For all NEFSC-affiliated research longline projects:

- Up to two loggerhead sea turtles may be captured per year and one of those takes may be lethal;
- Up to two Kemp's ridley sea turtles may be captured per year and one of those takes may be lethal; and
- Up to one leatherback sea turtle may be captured per year with a small chance of mortality.

<u>Captures and Mortality in Gillnet Gear</u>

For gillnet effort, the proposed actions include the addition of short-term research projects, some of which would occur in Southern New England and the Mid-Atlantic Bight. These short-term cooperative research projects will increase the number of gillnet sets, but the sets would be made for short durations (60 minutes or less) so the risk of sea turtle captures in gillnet gear increases, but the risk of serious injury or mortality does not increase relative to the Status Quo. Table 14 provides the number of estimated captures and serious injuries/mortalities for all NEFSC-affiliated gillnet projects that are likely to interact with sea turtles, rounded up to next highest whole number of turtles. All of the mortalities are associated with the NEFOP gillnet training cruises due to their relatively long (12 to 24 hour) soak times. For all NEFSC-affiliated research gillnet projects:

- Up to three Kemp's ridley sea turtles may be captured per year and one of those takes may be lethal; and
- Up to one green sea turtle may be captured per year with a remote chance of mortality.

Captures and Mortality in Dredge Gear
The lack of historical takes from research fishing and the substantial differences between research surveys and commercial fisheries makes it difficult to provide quantitative estimates of potential future takes of sea turtles in research dredge gear. Given the continued use of fishing gear with documented adverse interactions with sea turtles, there is a risk of future interactions during NEFSC fisheries and ecosystem research activities, both captures in the dredge gear and unobserved collisions with sea turtles on the sea floor that may cause injuries. However, based on the lack of observed research takes, the short tow times (15 minutes for most tows), and the relatively small number of research tows (less than 450 scallop tows and 150 surf clam/quahog tows per year compared to tens of thousands of commercial dredge tows), the risk of future adverse interactions with sea turtles is small, and interactions would likely be rare occurrences.

Conclusion
The effects of the proposed actions on sea turtles through disturbance, changes in prey availability, and contamination or degradation of habitat are discountable. The proposed actions includes several new training and communication programs intended to improve the effectiveness of the existing mitigation and monitoring measures used to protect sea turtles and other protected species. It is not possible to quantify how much these new measures would reduce impacts to sea turtles, but they would help reduce such impacts relative to past practices.

The presumed suite of short- and long-term research projects under the proposed actions involves more tows or sets using bottom trawl and gillnet gear. Most of these projects would use relatively short tow times or soak durations (30 minutes or less). The DPEA uses a number of assumptions to provide a conservative estimate of future captures/hookings/entanglements of sea turtles, including an estimate for serious injury and mortality up to two loggerhead, three Kemp's ridley, and one leatherback sea turtles per year, primarily in short-term cooperative research projects. Only one known mortality occurred from 2004-2013 out of 75 captured/hooked/entangled sea turtles documented in NEFSC fisheries and ecosystem research activities (a leatherback sea turtle in longline gear in the 2007 Apex Predators surveys), so the mortality level the NEFSC has estimated and we have presented here is a conservative one.

6.3 Effects to Shortnose Sturgeon

To date, there have been no documented cases of shortnose sturgeon captures in the NEFSC bottom/mid-water trawl or sea scallop dredge surveys or similar commercial fisheries. However, future catch of this species in the NEFSC's fisheries and ecosystem research is possible, and would most likely occur during trawl, fyke net, or seine surveys in coastal areas routinely studied by the NEFSC such as the Penobscot and Hudson River estuaries. In Maine, the Penobscot Estuarine Fish Community and Ecosystem Survey occurs annually for 12 days at sea in the Penobscot River Estuary throughout the year and involves 200 total trawls at the surface. Additionally, fyke net and beach seine surveys with the potential to capture shortnose sturgeon have been conducted in the past, but it is uncertain if those gear types will continue to be used for fish community sampling in the future. In New York and New Jersey, the Changes in the Community Structure of Benthic Fishes survey occurs annually for 20 days at sea in the Hudson River Estuary during the summer and involves 176 tows using a 16-foot trawl.

Our 2012 Opinion on the NEFSC's Penobscot River estuary studies anticipated the take of up to ten shortnose sturgeon over a five-year period, with one take leading to serious injury or mortality. Since the future use of beach seines and fyke nets during these surveys is currently unknown, we are not anticipating any additional take as a result of those activities, even though some level of take was estimated in the 2012 Opinion. And since there have yet to be any shortnose sturgeon captures documented in any gear type used during the past four years of these surveys, we believe that any takes that could result from future beach seine and fyke net use in the Penobscot River (and use of similar gears for fisheries and ecosystem research in the Hudson River estuary) would be subsumed in the trawl take estimate for the Penobscot. As a result, we anticipate the incidental capture of up to ten shortnose sturgeon as a result of the NEFSC's research activities in the Penobscot and Hudson River estuaries over the next five years.

While all shortnose sturgeon captured in the sampling gear during the NEFSC's fisheries and ecosystem research are largely assumed to be released alive and uninjured, a small portion may experience lethal injuries or death. Given the above information, and assuming the worst case (that captures in trawls, fyke nets, or seines have comparable mortality rates to captures in directed research trawls or commercial gillnets; 4% or less), it is reasonable to expect up to one mortality over the course of the proposed actions. However, by following proper handling protocols and carefully releasing the captured fish, the majority of effects that could lead to lethal mortalities can be avoided. Therefore, we expect no more than one individual would experience serious injuries or mortality as a result of interactions with NEFSC sampling gear over the five-year duration of the proposed actions.

6.4 Effects to Atlantic Sturgeon

Subadult and adult Atlantic sturgeon may be present in the action area year-round. In the marine environment, Atlantic sturgeon are most often captured in depths less than 50 meters. Some information suggests that captures in otter trawl gear are most likely to occur in waters with depths less than 30 meters and in depths less than 40 meters and mesh sizes greater than 10 inches for sink gillnet gear (ASMFC TC 2007).

Atlantic sturgeon have been caught on an infrequent but regular basis during the standard NEFSC bottom trawl surveys and both the spring and fall NEAMAP bottom trawl surveys. All of these fish were released alive and in apparent good condition. Two short-term cooperative research projects have recorded catches of one Atlantic sturgeon each, but the disposition of the fish (mortality, injury, or released alive) were not recorded. Both of these fish were caught before Atlantic sturgeon were listed under the ESA in 2012. The analysis of potential future takes uses catch rates from these surveys (fish caught per trawl) and the number of annual bottom trawls in the different surveys to estimate future takes. Because of the great diversity of potential locations, timing, and protocols for future short-term cooperative research projects, factors that could affect catch rates, data from the NEAMAP surveys was used to approximate catch rates for these types of research projects.

Given the past capture of Atlantic sturgeon in both the NEFSC and NEAMAP bottom trawl surveys, during cooperative research projects, as well as in commercial trawl and gillnet gear, it is reasonable to anticipate that Atlantic sturgeon will be present throughout the action area during the proposed actions. As described above, we expect that Atlantic sturgeon in the action area will originate from the NYB (51.7%), SA (21.9%), CB (11.8%), GOM (10.1%), and Carolina (2.4%) DPSs. It is possible that a small fraction (2.2%) of Atlantic sturgeon in the action area may be Canadian origin (from the St. John River).

The capture of Atlantic sturgeon in otter trawls used for commercial fisheries is well documented (see for example, Stein *et al.* 2004b and ASMFC TC 2007). Atlantic sturgeon are also captured incidentally in trawls used for scientific studies. The NEFSC and VIMS have recorded all Atlantic sturgeon interactions since the NEFSC and NEAMAP bottom trawl survey programs began, which allows us to predict future interactions as demonstrated in Table 15.

Table 15 provides estimates of Atlantic sturgeon bycatch for each set of research activities and the overall total for NEFSC-affiliated fisheries and ecosystem research. Based on this analysis, up to 119 Atlantic sturgeon per year (and up to 595 over the next five years) could be captured incidentally during NEFSC-affiliated research using bottom trawl gear. The DPS breakdown for these mortalities is expected to be as follows: 308 from the NYB, 130 from the SA DPS, 70 from the CB DPS, 60 from the GOM DPS, 14 from the Carolina DPS, and 13 of non-listed Canadian origin fish. These estimates are conservative in that they exceed past recorded takes and actual take levels would likely to be less than the estimates. Most Atlantic sturgeon caught would be expected to be released alive and in good condition based on past experience. Given the continued use of fishing gears that have caused mortality of Atlantic sturgeon in commercial fisheries, and since some cooperative research projects may include research protocols similar to commercial fishing conditions, there is a potential for NEFSC-affiliated fisheries research to cause mortality in the future. However, given the substantially shorter tow times and other differences between most research and commercial fishing, such incidents would likely be rare.

Table 15. Estimated Future Takes of Atlantic sturgeon under the NEFSC's Proposed Actions.

Research Activity	Trawls per year	Capture rate (sturgeon per trawl)	Estimated annual captures	Estimated Atlantic sturgeon takes per year (rounded up)
BTS	**800**	**0.00379**	**3.03**	**4**
NEAMAP (ME-NH)	**200**	**0.01083**	**2.17**	**3**
NEAMAP (VIMS)	**300**	**0.07556**	**22.67**	**23**
Other long-term research using bottom trawl gear	**910**	**0.00379**	**3.45**	**4**
Short-term cooperative research using bottom trawl gear	**1700**	**0.04967**	**84.44**	**85**
Total estimated Atlantic sturgeon takes per year in NEFSC-affiliated bottom trawl gear				**119**

The short duration of the tow and careful handling of any Atlantic sturgeon once on deck is likely to result in a low potential for mortality. None of the Atlantic sturgeon captured in previous NEFSC conducted or funded surveys have had any evidence of injury, and there have been no recorded mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s. To date, no injuries or mortalities of any sturgeon have been recorded. Based on this information, we expect that nearly all Atlantic sturgeon captured during the proposed actions will be alive and released uninjured.

NEFOP data indicates that mortality rates of Atlantic sturgeon caught in otter trawl gear are approximately 5% (Stein *et al.* 2004b; ASMFC TC 2007). Thus, we anticipate up to six Atlantic sturgeon mortalities annually (5% of 119 interactions) and up to 30 over the next five years. The DPS breakdown for these mortalities is expected to be as follows: 15 from the NYB, seven from the SA DPS, four from the CB DPS, three from the GOM DPS, and one from the Carolina DPS. Again, as indicated above, this is a conservative estimate of mortalities, which are likely to be much less during the proposed actions due to shorter tow times in the NEFSC's research surveys and cooperative research projects as compared to normal commercial trawling operations.

No other long-term or short-term research projects have reported any interactions with Atlantic sturgeon using gillnets or any other gear. However, gillnets are used for several long-term research projects, including the COASTSPAN Gillnet Surveys and NEFOP Observer Gillnet Training Trips. The COASTSPAN surveys use short set times (3 hours) and continuously run the net to collect target species (sharks) and release all other species quickly. Based on past experience, the potential for capturing Atlantic sturgeon in COASTSPAN surveys is low and the potential for mortality is negligible. The observer training trips and projected short-term cooperative research projects using sinking gillnets are relatively small and captures of Atlantic sturgeon would likely be rare events.

Several past short-term cooperative research projects have used gillnet gear for research in association with commercial fisheries that have caught Atlantic sturgeon in the past. One past project, "Bycatch Reduction Engineering Program (BREP) monkfish gillnet – sturgeon", was a pilot project to begin examining factors that could affect bycatch of Atlantic sturgeon in a commercial fishery. That project continued after Atlantic sturgeon were listed under the ESA in 2012, but it required a section 10 permit under the ESA; coordination moved to the NEFSC Protected Species Branch and the project was covered under directed research permits issued under the ESA (NMFS 2013a). Such directed research on ESA-listed species is not covered in the DPEA under the Preferred Alternative or in this Opinion. Any future proposed projects that have a reasonable chance of adverse interactions with ESA-listed species would either be covered under directed research permits or, if the effects were incidental to the intent of the research, would receive additional scrutiny (section 7 consultation) to ensure that the research does not harm the stock before it is issued a research permit.

6.5 Effects to the Gulf of Maine DPS of Atlantic Salmon

Atlantic salmon in the ocean are pelagic and highly surface oriented (Kocik and Sheehan 2006; Renkawitz *et al.* 2012). The preferred habitat of post-smolt salmon in the open ocean is principally the upper 10 meters of the water column (Baum 1997; ICES SGBYSAL 2005), although there is evidence of forays into deeper water for shorter periods. Adult Atlantic salmon demonstrate a wider depth profile (ICES SGBYSAL 2005), but overall salmon tend to be distributed in the surface layer, and all fishing activities covering this part of the water column are considered to have a potential to intercept salmon. Due to these factors and the limited abundance of Atlantic salmon, they are not typically caught in the research activities in question or in commercial fisheries of the U.S. Atlantic. Beland (1984) reported that fewer than 100 salmon per year were incidentally caught in commercial fisheries in the coastal waters of Maine.

While migrating, Atlantic salmon may be present throughout the water column and could interact with gear used during the NEFSC's fisheries and ecosystem research. Atlantic salmon interactions with bottom trawl and gillnet gear are likely at times when and in areas where their distribution overlaps with the fishing activities. Atlantic salmon also may encounter hooks from both hook-and-line gear and longline gear while traveling through the water column.

Only two Atlantic salmon have been captured during the NEFSC's annual fisheries and ecosystem surveys; one in the NEFSC bottom trawl survey in 1977 and the second during the spring 2012 bottom trawl survey. Both fish were captured alive along the coastline of Maine. There have been no records of Atlantic salmon captures in short-term cooperative research projects. However, future NEFSC research activities aboard both NOAA vessels and cooperative research fishing vessels could encounter Atlantic salmon. All observed takes of Atlantic salmon during NEFSC research activities to this point have occurred in bottom trawls, while all observed takes during commercial fishing operations in the Northeast U.S. have occurred in bottom trawls or gillnets. It is also possible that bottom longline gear, which is occasionally used in the NEFSC's fisheries and ecosystem research, could hook Atlantic salmon while foraging, but there have been no reported interactions.

Adult Atlantic salmon may be present in the action area year-round, however they are rarely captured in the marine environment. NEFOP and ASM data from 1989-2014 show records of incidental Atlantic salmon bycatch in seven of 25 years, with a total of 15 individuals caught. There is no information available on the genetics of these caught Atlantic salmon, so we do not know how many of these salmon are part of the Gulf of Maine DPS. It is likely that at least some of these salmon, particularly those caught south of Cape Cod, originated from the stocking program in the Connecticut River. The Atlantic salmon caught off the coast of Maine are more likely to be of the Gulf of Maine DPS. However, as their genetic status is unknown, we will assume for the purposes of this analysis that all 15 are Gulf of Maine DPS salmon.

Of the observed incidentally caught Atlantic salmon, ten were listed as "discarded," which is assumed to be a live discard (J. Kocik, pers. comm., February 11, 2013). Five of the 15 (33%) were listed as mortalities. The incidental takes of Atlantic salmon occurred using sink gillnets (11) and bottom otter trawls (4). There does not seem to be a seasonal pattern to the observed captures; they occurred in the months of November (6), June (3), March (2), April (2), May (1), and August (1). The most recent data from 2004-2014 show incidental captures in the multispecies and monkfish fisheries in offshore areas (statistical areas 522 and 525) during the spring, and in the Gulf of Maine (statistical areas 513, 514, and 515) in the spring/summer.

Based on the few bycatch records available for this species in both fisheries/ecosystem research and commercial fishing operations, we anticipate up to one Atlantic salmon interaction will occur annually as a result of the proposed actions (for a total of five interactions over the next five years), with two interactions every five years anticipated to be lethal (based on the 33% mortality rate as seen in the fisheries observer data from 1989-2014).

6.6 Effects due to Interactions with Fisheries and Ecosystem Research Vessels

Vessel strikes are a threat to a number of marine species worldwide including ESA-listed whales. Vessel collisions with marine mammals can result in death by massive trauma, hemorrhaging, broken bones, and propeller wounds (Knowlton and Kraus 2001; Campbell and Malone 2007). When whale species and large vessels are involved, the struck whale can occasionally be found draped across the ship's bulbous bow when it arrives in port. Massive propeller wounds can be immediately fatal. However, if relatively superficial, some individuals can recover from seemingly serious collisions, as evidenced by photographic time series of deep lacerations healing on individual animals (Silber *et al.* 2009). Vessel strikes of whales are a growing problem internationally (Van Waerebeek and Leaper 2008), particularly where endangered or depleted species are involved. A contributing factor is the increase in maritime commerce, which is expected to nearly double over the next 15 years in U.S. ports (U.S. Department of Transportation 2008). A 2003 report from the NOAA's Large Whale Ship Strike Database found that only five (4%) of 134 reported incidents from 1975-2002 where the type of vessel was known were either fishing or research vessels. Analysis of the ship strike database indicates that faster and larger types of vessels are more likely to be involved in whale ship strikes.

Sperm whales generally react only to vessels approaching within several hundred meters; however, some individuals may display avoidance behavior, such as quick diving (Wursig *et al.* 1998; Magalhaes *et al.* 2002). One study showed that after diving, sperm whales showed a reduced timeframe from when they emitting the first click than before vessel interaction (Richter *et al.* 2006). Reactions to large fishery survey and research vessels are not well documented, but smaller vessels, which generate more noise in higher frequency bands, have been shown to cause these species to alter their breathing intervals and echolocation patterns. There have been no previously recorded takes of sperm whales in the NEFSC's fisheries and ecosystem research and the LOA application does not include any estimated Level A harassment (injury), serious injury, or mortality of this species during the next five years. Given the training, monitoring, and mitigation measures in place and the lack of historical takes, the NEFSC or its cooperative research partners do not expect to have any adverse vessel interactions with sperm whales.

Sea turtles are known to be injured and/or killed as a result of being struck by vessels on the water and as a result of capture in or physical contact with fishing gear. Interactions between vessels and sea turtles occur and can take many forms, from the most severe (death or bisection of an animal or penetration to the viscera), to severed limbs or cracks to the carapace which can also lead to mortality directly or indirectly. Sea turtle stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993, about 9% of living and dead stranded sea turtles had propeller or other boat strike injuries (Lutcavage *et al.* 1997). According to 2001 STSSN stranding data, at least 33 sea turtles (including loggerhead, green, Kemp's ridley and leatherbacks) that stranded on beaches within the Northeast (Maine through North Carolina) were struck by a boat. This number underestimates the actual number of boat strikes that occur since not every boat-struck turtle will strand, every stranded turtle will not be found, and many stranded turtles are too decomposed to determine whether the turtle was struck by a boat. It should be noted, however, that it is not known whether all boat strikes were the cause of death or whether they occurred post-mortem (NMFS SEFSC 2001).

Information is lacking on the type or speed of vessels involved in turtle vessel strikes. However, there does appear to be a correlation between the number of vessel struck turtles and the level of recreational boat traffic (NRC 1990). Although little is known about a sea turtle's reaction to vessel traffic, it is generally assumed that sea turtles are more likely to avoid injury from slower moving vessels since the turtle has more time to maneuver and avoid the vessel. In addition, the risk of ship strike will be influenced by the amount of time the animal remains near the surface of the water. With respect to the proposed actions, the effects to sea turtles as a result of vessel activities are discountable. The small number of vessels that will operate on the water as a result of the proposed actions are unlikely to strike sea turtles in the action area given that: (a) the vessels will operate/travel at a slow speed such that sea turtles would have the speed and maneuverability to avoid contact with the vessel and (b) sea turtles spend part of their time at depths out of range of a vessel collision.

As noted in the listing rules and status reviews for these species, and the recovery plan for shortnose sturgeon, vessel strikes have been identified as a threat to shortnose and Atlantic sturgeon in certain regions. While the exact number of sturgeon killed as a result of being struck by boat hulls or propellers is unknown, it is an area of concern in the Delaware and James Rivers. Brown and Murphy (2010) examined 28 dead Atlantic sturgeon observed in the Delaware River from 2005-2008. Fifty-percent of the mortalities resulted from apparent vessel strikes and 71% of these (ten of 14) had injuries consistent with being struck by a large vessel (Brown and Murphy 2010). Eight of the 14 vessel struck sturgeon were adult-sized fish (Brown and Murphy 2010). Given the time of year in which the fish were observed (predominantly May through July; Brown and Murphy 2010), it is likely that many of the adults were migrating through the river to the spawning grounds.

The factors relevant to determining the risk to shortnose and Atlantic sturgeon from vessel strikes are currently unknown, but they may be related to size and speed of the vessels, navigational clearance (i.e., depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of sturgeon in the area (e.g., foraging, migrating, etc.). The risk of vessel strikes between sturgeon and research/fishing vessels operating in the open ocean or large estuaries is likely to be low given that the vessels are likely to be operating at slow speeds and there are no restrictions forcing shortnose or Atlantic sturgeon into close proximity with the vessel as may be present in some rivers.

Given the large volume of vessel traffic in the action area and the wide variability in traffic on any given day, the increase in traffic (one or two vessels at a time, traveling at relatively slow speeds) associated with the proposed actions is extremely small. Given the small and localized increase in vessel traffic that would result from the NEFSC's fisheries and ecosystem research, and the depth of the water and ability of sturgeon to avoid vessels and maneuver in the open ocean, it is unlikely that there would be any detectable increase in the risk of vessel strike. As such, effects to sturgeon from the increase in vessel traffic are likely to be discountable.

The threats assessment done for Atlantic salmon as part of the 2009 endangered listing of the expanded Gulf of Maine DPS did not list vessel strikes as a high priority threat (74 FR 29344; June 19, 2009). There is no data currently available on vessel strikes and Atlantic salmon.

6.7 Effects to Prey

Sperm whales are frequently found in locations of high productivity due to upwelling or steep underwater topography, such as continental slopes, seamounts, or canyon features (Jaquet and Whitehead 1996; Jaquet *et al.* 1996). Cold-core eddy features are also attractive to sperm whales, likely because of the large numbers of squid that are drawn to the high concentrations of plankton associated with these features. Surface waters with sharp horizontal thermal gradients, such as along the Gulf Stream in the Atlantic, may also be temporary feeding areas for sperm whales (Waring *et al.* 1993; Jaquet *et al.* 1996; Griffin 1999). At present, there is no information indicating that the NEFSC's fisheries and ecosystem research studies directly target large numbers of or negatively affect (through either direct capture or acoustic harassment) pelagic squid, which are the preferred prey of sperm whales. Because of this, we have determined that any effects to sperm whale prey will be insignificant.

Sea turtles could be negatively affected by the loss of prey as a result of mobile fishing gear that removes or incidentally kills such prey during the proposed actions. However, the amount of potential prey that will be disturbed or removed is minimal. The gears to be used during the proposed actions are expected to catch a variety of organisms including fish and crab species. However, none of the bycatch species expected from any activity (i.e., utilizing otter trawl and gillnet gear) proposed in this Opinion are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles (Rebel 1974; Mortimer 1982; Bjorndal 1985, 1997; USFWS and NMFS 1992). Those organisms that are caught in either trawl or gillnet will be sampled according to the survey protocol. Species that meet the sampling criteria will be sampled for scientific purposes and may not be returned to the water, while the other species will be returned to the water alive, dead, or injured to the extent that they will subsequently die. Nearly all of the species that will be retained for further study are fish. Crabs, on the other hand, which are the preferred prey of loggerhead and Kemp's ridley sea turtles, will often not be retained for further study, and thus would still be available as prey for loggerheads and Kemp's ridleys when returned to the water, as both of these species of sea turtles are known to eat a variety of live prey as well as scavenge dead organisms (Lutcavage and Musick 1985; Keinath *et al.* 1987; Dodd 1988; Burke *et al.* 1993, 1994; Morreale and Standora 2005). Thus, the proposed actions considered here are expected to have an insignificant effect on the availability of prey for loggerhead and Kemp's ridley sea turtles in the action area given that: (a) the sea turtle food items that are returned to the water could still be preyed upon by loggerheads and Kemp's ridleys, (b) the number of trawl tows and gillnet hauls for the surveys and study are limited in scope and duration, (c) the priority species that will be retained for scientific analysis are almost entirely fish species, which are not preferred prey for loggerheads and Kemp's ridleys (Keinath *et al.* 1987; Lutcavage and Musick 1985; Burke *et al.* 1993, 1994; Morreale and Standora 2005), and (d) and there is no evidence loggerhead or Kemp's ridley sea turtles are prey limited.

Shortnose and Atlantic sturgeon use the action area as a migratory route and for overwintering and foraging. Any effects on habitat due to fishing and ecosystem research gear are most likely to be on sturgeon prey items, as discussed above. Shortnose and Atlantic sturgeon are known to aggregate in certain areas and at certain times of the year, and some of these areas experience high fishing effort. Despite the overlap in aggregations with some areas of high fishing effort, we have no information that indicates negative effects on sturgeon prey items, although foraging, overwintering, and migrations may be temporarily disturbed by the use of bottom fishing gear. Gillnet gear may also impede shortnose and Atlantic sturgeon migrations, but the effects are also expected to be insignificant.

Shortnose and Atlantic sturgeon feed primarily on small benthic invertebrates and occasionally on small fish. Because of the small size or benthic nature of these prey species, it is unlikely that the proposed actions will capture any sturgeon prey items. Thus, the surveys and study will not affect the availability of prey for sturgeon. Again, any effects to prey will be limited to minor disturbances to the river/estuary/ocean bottom from the trawl and gillnet gear. Because of this, we have determined that any effects to sturgeon prey or foraging sturgeon will be insignificant.

Atlantic salmon also use the action area as a migratory route and for foraging. The effects on habitat due to fishing gears used in the NEFSC's research are likely to affect some Atlantic salmon prey items. Aggregations of Atlantic salmon may occur both at the post-smolt stage and after their first winter at sea, but most evidence indicates that they travel individually as adults (Reddin 1985). Foraging and travel activity may be temporarily disturbed by the use of bottom fishing gears, but the effects are expected to be insignificant. Gillnet gear may also impede Atlantic salmon travel, but the effects are also expected to be insignificant.

6.8 Effects to Habitat

A panel of experts has previously concluded that the effects of even light weight otter trawl gear would include: (1) the scraping or plowing of the doors on the bottom, sometimes creating furrows along their path, (2) sediment suspension resulting from the turbulence caused by the doors and the ground gear on the bottom, (3) the removal or damage to benthic or demersal species, and (4) the removal or damage to structure forming biota. The panel also concluded that the greatest impacts from otter trawls occur in high and low energy gravel habitats and in hard clay outcroppings, and that sand habitats were the least likely to be impacted (NREFHSC 2002). The areas to be surveyed for the NEFSC's conducted and funded research include very few habitats that are purely gravel or hard clay—so few that the area encompassed by these habitats is insignificant compared to the area encompassed by sand and silt type habitats, which are more resilient to bottom trawling. For benthic feeding sea turtles, shortnose sturgeon, and Atlantic sturgeon, the effects on habitat due to bottom otter trawl gear would be felt as an effect on their benthic prey species. As stated above, the effects on sea turtle and sturgeon benthic prey items from bottom trawl gear are expected to be insignificant.

As gillnet and pot/trap gears are a form of fixed gear (i.e., stationary, not moving), limited effects to bottom habitat are possible as a result of utilizing these forms of fish harvest gear. The gear rests on the bottom and is capable of getting pushed by slow moving currents, or, when the gear is in process of being retrieved. Because the gillnet and pot/trap gear hauls proposed in this Opinion will not be conducted during adverse weather conditions (i.e., when ocean currents may be stronger) and will have brief soak durations, adverse effects on habitat are not expected. As stated above, the effects on sea turtle and sturgeon benthic prey items from fixed gear are expected to be insignificant.

In regards to effects on the pelagic habitat of sperm whales, some sea turtles (e.g., leatherbacks), and Atlantic salmon, we do not anticipate any adverse effects from the NEFSC's fisheries and ecosystem research on those areas since the gear will simply be towed or dropped through them. The gears, active acoustic sources, and vessels to be used by the NEFSC and its partners are not expected to significantly affect the prevailing currents, water quality, or other environmental conditions of those habitats.

7.0 CUMULATIVE EFFECTS

Cumulative effects as defined in 50 CFR 402.02 include the effects of future State, tribal, local, or private actions that are reasonably certain to occur within the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. For that reason, future effects of other Federal fisheries are not considered in this section of the document; all Federal fisheries that may affect listed species are the subject of formal section 7 consultations. Effects of ongoing Federal activities, including other fisheries, are considered in the *Environmental Baseline* and *Status of the Species* sections above and are also factored into the *Integration and Synthesis of Effects* section below.

Sources of human-induced mortality, injury, and/or harassment of sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon in the action area that are reasonably certain to occur in the future include interactions in state-regulated and recreational fishing activities, vessel collisions, ingestion of plastic debris, pollution, global climate change, coastal development, and catastrophic events. While the combination of these activities may affect sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon, preventing or slowing a species' recovery, the magnitude of these effects is currently unknown.

State Water Fisheries - Future recreational and commercial fishing activities in state waters may capture, injure, or kill sea turtles, sturgeon, and salmon. However, it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the *Environmental Baseline* section. Shortnose and Atlantic sturgeon are captured and killed in fishing gear operating in the action area; however, at this time we are not able to quantify the number of interactions that occur. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the *Status of the Species* and *Environmental Baseline* sections.

Fishing activities are considered one of the most significant causes of death and serious injury for sea turtles. Finkbeiner *et al*. (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). Fishing gear in state waters, including bottom trawls, gillnets, trap/pot gear, and pound nets, interacts with sea turtles each year. NMFS is working with state agencies to address the bycatch of sea turtles in state water fisheries within the action area of this consultation where information exists to show that these fisheries capture sea turtles. Action has been taken by some states to reduce or remove the likelihood of sea turtle bycatch and/or the likelihood of serious injury or mortality in one or more gear types. However, given that state managed commercial and recreational fisheries along the U.S. Atlantic coast are reasonably certain to occur within the action area in the foreseeable future, additional interactions of sea turtles with these fisheries are anticipated. There is insufficient information to quantify the number of sea turtle interactions with state water fisheries as well as the number of sea turtles injured or killed as a result of these interactions. While actions have been taken to reduce sea turtle bycatch in some state water fisheries, the overall effect of these actions is unknown, and the future effects of state water fisheries on sea turtles cannot be quantified. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the *Status of the Species* and *Environmental Baseline* sections.

Vessel Interactions - NMFS's STSSN data indicate that vessel interactions are responsible for a number of sea turtle strandings within the action area each year. In the U.S. Atlantic from 1997-2005, 14.9% of all stranded loggerheads were documented as having sustained some type of propeller or collision injuries (NMFS and USFWS 2007a). The incidence of propeller wounds rose from approximately 10% in the late 1980s to a record high of 20.5% in 2004 (STSSN database). Such collisions are reasonably certain to continue into the future. Collisions with boats can stun, injure, or kill sea turtles, and many live-captured and stranded sea turtles have obvious propeller or collision marks (Dwyer *et al*. 2003). However, it is not always clear whether the collision occurred pre- or post-mortem. NMFS believes that vessel interactions with sea turtles will continue in the future. An estimate of the number of sea turtles that will likely be killed by vessels is not available at this time. Similarly, we are unable at this time to assess the risk that vessel operations in the action area pose to Atlantic sturgeon. While vessel strikes have been documented in several rivers, the extent that interactions occur in the marine environment is currently unknown. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the *Status of the Species* and *Environmental Baseline* sections.

Pollution and Contaminants - Human activities in the action area causing pollution are reasonably certain to continue in the future, as are impacts from them on sperm whale, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon. However, the level of impacts cannot be projected. Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contamination may have effects on listed species' reproduction and survival. Excessive turbidity due to coastal development and/or construction sites could influence marine mammal, sea turtle, sturgeon, or salmon foraging ability. Marine debris (e.g., discarded fishing line or lines from boats, plastics) also has the potential to entangle ESA-listed species in the water or to be fed upon by them. Sea turtles commonly ingest plastic or mistake debris for food and sometimes this may lead to asphyxiation. This Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the *Status of the Species* and *Environmental Baseline* sections.

Underwater Noise - In past consultations, NMFS has concluded that phenomena like sound do not accumulate, although phenomena like the acreage of habitat destroyed and concentrations of toxic chemicals, sediment, and other pollutants do accumulate. Here, we have concluded that the effects of multiple exposures to active acoustic sources are not likely to accumulate through altered energy budgets caused by avoidance behavior (reducing the amount of time available to forage), physiological stress responses, or the costs of changing behavioral states (small decreases in the current and expected reproductive success of individuals exposed to the stressors) because these costs primarily occur because of avoidance behavior and altered energy budgets. In particular, we have also concluded that sperm whales would be exposed in foraging areas or migration routes where trivial increases in feeding duration, effectiveness, or transit would eliminate the costs of these phenomena on the individuals that might be exposed.

The number of individuals "taken" gets larger when we accumulative them through addition, but the effect of that "take" on the survival or reproductive success of the animals themselves would not accumulate in the same way. As a result, we do not expect that instances of exposing sperm whales to active acoustic sources each year or over five years would result in effects that would be greater than we would expect from a single exposure event. To the contrary, we do not expect the effects of the "take" to have any additive, interactive, or synergistic effect on the individual animals, the populations those individuals represent, or the species those populations comprise.

In the future, *global climate change* is expected to continue and may impact ESA-listed species and their habitat in the action area. However, as noted in the *Status of the Species* and *Environmental Baseline* sections above, given the likely rate of change associated with climate impacts (i.e., the century scale), it is unlikely that climate related impacts will have a significant effect on the status of any ESA-listed species over the temporal scale of the proposed actions (i.e., over the next five years) or that in this time period, the abundance, distribution, or behavior of these species in the action area will change as a result of climate change related impacts.

8.0 INTEGRATION AND SYNTHESIS OF EFFECTS

In the effects analysis outlined above, we considered potential effects from the NEFSC's conducted and funded research over the next five years. These effects include fishing with multiple gear types including trawls, dredges, hook and line gear, gillnets, pot/trap gear, and other net gear. In addition to these gear-related effects, we considered the potential for interactions between ESA-listed species and research/fishing vessels, impacts to their habitats and prey, and noise effects on these species from active acoustic sources used in the studies.

We have estimated that the NEFSC's fisheries and ecosystem research will result in the capture of up to 85 NWA DPS loggerheads, 95 Kemp's ridleys, ten green, and ten leatherback sea turtles; up to ten shortnose sturgeon; up to 595 Atlantic sturgeon; and up to five Gulf of Maine

DPS Atlantic salmon over a five-year period. Up to ten loggerhead, 15 Kemp's ridley, five leatherback, one shortnose sturgeon, 30 Atlantic sturgeon, and two Atlantic salmon interactions over the five-year period are expected to result in serious injury or mortality. Up to 15 sperm whales are expected to experience acoustic harassment from underwater sound sources over a five-year period, yet no injuries or mortalities are anticipated during the proposed actions and all animals are expected to recover from acoustic harassment without any reduction in fitness or impact on survival. As explained in the *Effects of the Action* section, all other effects to sperm whales, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon from the NEFSC's fisheries and ecosystem research, including to their prey and habitat, will be insignificant.

In the discussion below, we consider whether the effects of the proposed actions reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the listed species that will be adversely affected by the actions. The purpose of this analysis is to determine whether the proposed actions, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species.

In the USFWS/NMFS Section 7 Handbook (USFWS and NMFS 1998), for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter."

Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." We summarize below the status of the species and consider whether the proposed actions will result in reductions in reproduction, numbers or distribution of these species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed actions would reduce appreciably the likelihood of both the survival and recovery of these species, as those terms are defined for purposes of the ESA.

8.1 Sperm Whales

As explained in the Opinion, we do not anticipate any injury or mortality of sperm whales to result from the proposed actions. Temporary, short-term behavioral effects during exposure to active acoustic sources between 160 and 180 dB re 1uPa such as cessation of feeding, resting, or other activities or temporary alterations in breathing, vocalizing, or diving rates are likely, although these effects are not likely to affect an individual's likelihood of survival or reproduction. We do not anticipate any impacts to the health, survival, or reproductive success of any individual sperm whales. All other effects to sperm whales, including impacts from vessel traffic and impacts to habitat and prey resources, will be insignificant and discountable.

The survival of any sperm whales will not be affected by the proposed actions. As such, there will be no reduction in the numbers of sperm whales and no change in the status of this species or its trend. Reproductive potential of sperm whales is not expected to be affected in any way. As all behavioral disruption will be minor and temporary and will not cause a delay or disruption of any essential behavior including reproduction, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of ensonified areas. The proposed action is not likely to reduce distribution because the action will not impede sperm whales from accessing any seasonal concentration areas, including foraging or overwintering grounds in the action area or elsewhere.

Based on the information provided above, the behavioral disturbance of sperm whales due to exposure to noise between 160 and 180 dB re 1uPa (equivalent to MMPA level B harassment) during the use of active acoustic sources over a five-year period, will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality, and therefore, no reduction in the numbers of sperm whales; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; and (3) the action will have only a minor and temporary effect on the distribution of sperm whales in the action area (related to the temporary avoidance of temporarily ensonified areas) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the species will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. Recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the potential for the species to rebuild to a point where listing is no longer appropriate.

The proposed actions are not likely to result in any mortality or reductions in fitness or future reproductive output, and therefore, are not expected to affect the persistence of the species. There will not be a change in the status or trend of the species. As there will be no reduction in numbers or future reproduction, the actions would not cause any reduction in the likelihood of improvement in the status of the species. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the actions will not cause any mortality or reduction of overall reproductive fitness for the species. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the species can be brought to the point at which it is no longer listed under the ESA. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Based on the active acoustic sources being used, sperm whales are expected to experience non-injurious, non-lethal Level B harassment under the MMPA on up to 15 occasions over the course of the LOA period. The evidence available suggests that sperm whales, like other toothed whales, are not very sensitive to low-frequency sounds. Despite the limited number of studies, the available evidence suggests that the risk of injury, masking, stranding, resonance effects, or behavioral effects in sperm whales is very low. The best scientific and commercial data available suggests that active acoustic transmissions from the three predominant sources used by the NEFSC are likely to elicit short-term effects on sperm whales that are known to have no long-term, adverse consequences for the biology or ecology of the individual whales exposed to the sources.

We conclude that the fisheries and ecosystem research the NEFSC proposes to conduct and fund in the action area, consistent with the MMPA LOA and cumulatively over a five-year period of the impending MMPA rule, are likely to have short-term, adverse effects on individual whales (i.e., 15 instances of acoustic harassment over a five-year period). However, they are not likely to adversely affect the population dynamics of sperm whales in ways that would reduce their reproduction, numbers, or distribution. As a result, these active acoustic sources are not expected to appreciably reduce the likelihood that sperm whales can survive and recover in the wild.

8.2 Northwest Atlantic DPS of Loggerhead Sea Turtles

The Northwest Atlantic DPS of loggerhead sea turtles is listed as "threatened" under the ESA. It takes decades for loggerhead sea turtles to reach maturity. Once they have reached maturity, females typically lay multiple clutches of eggs within a season, but do not typically lay eggs every season (NMFS and USFWS 2008). There are many natural and anthropogenic factors affecting the survival of loggerheads prior to their reaching maturity as well as for those adults who have reached maturity. As described in the *Status of the Species, Environmental Baseline*, and *Cumulative Effects* sections above, loggerhead sea turtles in the action area continue to be affected by multiple anthropogenic impacts including bycatch in commercial and recreational fisheries, habitat alteration, dredging, power plant intakes, and other factors that result in mortality of individuals at all life stages. Negative impacts causing death of various age classes occur both on land and in the water. Many actions have been taken to address known negative impacts to loggerhead sea turtles. However, many remain unaddressed, have not been sufficiently addressed, or have been addressed in some manner but whose success cannot be quantified.

The SEFSC (2009) estimated the number of adult females in the NWA DPS at 30,000, and if a 1:1 adult sex ratio is assumed, the result is 60,000 adults in this DPS. Based on the reviews of nesting data, as well as information on population abundance and trends, NMFS and USFWS determined in the September 2011 listing rule that the NWA DPS should be listed as threatened. They found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats.

In this Opinion, we have considered the potential impacts of the proposed action on the NWA DPS of loggerhead sea turtles. We have estimated that 85 loggerheads are likely to be captured in the proposed actions over a five-year period and that ten of those turtles may be seriously injured or killed. All other effects to loggerhead sea turtles, including effects to prey, are expected to be insignificant and discountable.

Capture during the surveys will temporarily prevent these sea turtles from carrying out essential behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the turtles are returned to the water. The capture of live loggerhead sea turtles is not likely to reduce the numbers of loggerhead sea turtles in the action area, the numbers of loggerheads in any subpopulation or the species as a whole. Similarly, as the capture of live loggerhead sea turtles will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live loggerhead sea turtles is also not likely to affect the distribution of loggerhead sea turtles in the action area or affect the distribution of sea turtles throughout their range. As any effects to individual live loggerhead sea turtles temporarily removed from the water will be minor and temporary there are not anticipated to be any population level impacts.

The lethal removal of up to ten loggerhead sea turtles from the action area over the next five years would be expected to reduce the number of loggerhead sea turtles from the recovery unit of which they originated as compared to the number of loggerheads that would have been present in the absence of the proposed actions (assuming all other variables remained the same). However, this does not necessarily mean that these recovery units will experience reductions in reproduction, numbers or distribution in response to these effects to the extent that survival and recovery would be appreciably reduced. The final revised recovery plan for loggerheads compiled the most recent information on mean number of loggerhead nests and the approximated counts of nesting females per year for four of the five identified recovery units (i.e., nesting groups). They are: (1) for the NRU, a mean of 5,215 loggerhead nests per year with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year with approximately 221 females nesting per year. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit.

It is likely that the loggerhead sea turtles captured during the surveys or study originate from several of the recovery units. Limited information is available on the genetic makeup of sea turtles in the Mid-Atlantic, where the majority of sea turtle interactions are expected to occur. Cohorts from each of the five western Atlantic subpopulations are expected to occur in the action area. Genetic analysis of samples collected from immature loggerhead sea turtles captured in pound nets in the Pamlico-Albemarle Estuarine Complex in North Carolina from September-December of 1995-1997 indicated that cohorts from all five western Atlantic subpopulations were present (Bass *et al.* 2004). In a separate study, genetic analysis of samples collected from loggerhead sea turtles from Massachusetts to Florida found that all five western Atlantic loggerhead subpopulations were represented (Bowen *et al.* 2004). Bass *et al.* (2004) found that 80% of the juveniles and sub-adults utilizing the foraging habitat originated from the south Florida nesting population, 12% from the northern subpopulation, 6% from the Yucatan subpopulation, and 2% from other rookeries. The previously defined loggerhead subpopulations do not share the exact delineations of the recovery units identified in the 2008 recovery plan. However, the PFRU encompasses both the south Florida and Florida panhandle subpopulations, the NRU is roughly equivalent to the northern nesting group, the Dry Tortugas subpopulation is equivalent to the DTRU, and the Yucatan subpopulation is included in the GCRU.

Based on the genetic analysis presented in Bass *et al.* (2004) and the small number of loggerheads from the DTRU or the NGMRU likely to occur in the action area it is extremely unlikely that the loggerheads likely to be killed during the proposed actions will originate from either of these recovery units. The majority, at least 80% of the loggerheads captured, are likely to have originated from the PFRU, with the remainder from the NRU and GCRU. As such, of the 85 loggerheads likely to be captured over the next five years, 70 are expected to be from the PFRU, ten from the NRU, and five from the GCRU. As explained above, only ten loggerhead mortalities are expected to result during the proposed actions every five years. As it is impossible to predict whether these turtles will be from the PFRU, the NRU or the GCRU, we consider below the effects of the mortality of ten loggerheads from any of the these three recovery units.

As noted above, the most recent population estimates indicate that there are approximately 15,735 females nesting annually in the PFRU and approximately 1,272 females nesting per year in the NRU. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit; however, the 2008 recovery plan indicates that the Yucatan nesting aggregation has at least 1,000 nesting females annually. As the numbers outlined here are only for nesting females, the total number of loggerhead sea turtles in each recovery unit is likely significantly higher. The loss of ten loggerheads represents an extremely small percentage of the number of sea turtles in the PFRU. Even if the total population was limited to 15,735 loggerheads, the loss of ten individuals would represent approximately 0.06% of the population. Similarly, the loss of ten loggerheads from the NRU represents an extremely small percentage of the recovery unit. Even if the total population was limited to 1,272 sea turtles, the loss of ten individuals would represent approximately 0.79% of the population. The loss of ten loggerheads from the GCRU, which is expected to support at least 1,000 nesting females, represents just 1% of the population. The loss of such a small percentage of the individuals from any of these recovery units represents an even smaller percentage of the species as a whole. As such, it is unlikely that the death of ten loggerhead sea turtles will have a detectable effect on the numbers and population trends of loggerheads in these recovery units or the number of loggerheads in the population as a whole. Additionally, this action is not likely to reduce distribution of loggerheads because the action will only result in temporary delays for foraging and migrating loggerheads and will not impede any loggerheads from accessing suitable foraging grounds and or disrupt other migratory behaviors.

In general, while the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of loggerhead sea turtles because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, and there are several thousand individuals in the population.

Based on the information provided above, the death of no more than ten loggerhead sea turtles during the proposed actions will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect loggerheads in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent loggerheads from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of ten loggerheads over five years represents an extremely small percentage of the species as a whole; (2) the loss of these loggerheads will not change the status or trends of any nesting aggregation, recovery unit or the species as a whole; (3) the loss of these loggerheads is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these loggerheads is likely to have an undetectable effect on reproductive output of any nesting aggregation or the species as a whole; (5) the actions will have no effect on the distribution of loggerheads in the action area or throughout its range; and (6) the actions will have no effect on the ability of loggerheads to shelter and only an insignificant effect on individual foraging loggerheads.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that loggerhead sea turtles will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed action will affect the likelihood that the NWA DPS of loggerheads can rebuild to a point where listing is no longer appropriate. In 2008, NMFS and the USFWS issued a recovery plan for the Northwest Atlantic population of loggerheads (NMFS and USFWS 2008). The plan includes demographic recovery criteria as well as a list of tasks that must be accomplished. Demographic recovery criteria are included for each of the five recovery units. These criteria focus on sustained increases in the number of nests laid and the number of nesting females in each recovery unit, an increase in abundance on foraging grounds, and ensuring that trends in neritic strandings are not increasing at a rate greater than trends in in-water abundance. The recovery tasks focus on protecting habitats, minimizing and managing predation and disease, and minimizing anthropogenic mortalities.

Loggerheads have an increasing trend; as explained above, the loss of ten loggerheads as a result of the proposed actions will not affect the population trend. The number of loggerheads likely to die as a result of the proposed actions is an extremely small percentage of any recovery unit or the DPS as a whole. This loss will not affect the likelihood that the population will reach the size necessary for recovery or the rate at which recovery will occur. As such, the proposed actions will not affect the likelihood that the demographic criteria will be achieved or the timeline on which they will be achieved. The action area does not include nesting beaches; all effects to habitat will be insignificant and discountable; therefore, the proposed actions will have no effect on the likelihood that habitat based recovery criteria will be achieved. The proposed actions will also not affect the ability of any of the recovery tasks to be accomplished.

In summary, the effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the action will not prevent the species from growing in a way that leads to recovery and the action will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of loggerheads and a small reduction in the amount of potential reproduction due to the loss of these individuals, these effects will be undetectable over the long-term and the actions are not expected to have long term impacts on the future growth of the population or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions will not appreciably reduce the likelihood that loggerhead sea turtles can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual loggerhead sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of other threats, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of the NWA DPS of loggerhead sea turtles.

8.3 Kemp's Ridley Sea Turtles

Kemp's Ridley sea turtles are listed as a single species classified as "endangered" under the ESA. Kemp's ridleys occur in the Atlantic Ocean and Gulf of Mexico. The only major nesting site for Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007c).

Nest count data provides the best available information on the number of adult females nesting each year. As is the case with the other sea turtles species discussed above, nest count data must be interpreted with caution given that these estimates provide a minimum count of the number of nesting Kemp's ridley sea turtles. In addition, the estimates do not account for adult males or juveniles of either sex. Without information on the proportion of adult males to females, and the age structure of the Kemp's ridley population, nest counts cannot be used to estimate the total population size (Meylan 1982; Ross 1996; Zurita *et al.* 2003; Hawkes *et al.* 2005; letter to J. Lecky, NMFS Office of Protected Resources, from N. Thompson, NMFS Northeast Fisheries Science Center, December 4, 2007). Nevertheless, the nesting data does provide valuable information on the extent of Kemp's ridley nesting and the trend in the number of nests laid. Estimates of the adult female nesting population reached a low of approximately 250-300 in 1985 (USFWS and NMFS 1992; TEWG 2000). From 1985 to 1999, the number of nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3% per year

(TEWG 2000). Current estimates suggest an adult female population of 7,000-8,000 Kemp's ridleys (NMFS and USFWS 2007c).

The most recent review of the Kemp's ridleys suggests that this species is in the early stages of recovery (NMFS and USFWS 2007b). Nest count data indicate increased nesting and increased numbers of nesting females in the population. NMFS also takes into account a number of recent conservation actions including the protection of females, nests, and hatchlings on nesting beaches since the 1960s and the enhancement of survival in marine habitats through the implementation of TEDs in the early 1990s and a decrease in the amount of shrimping off the coast of Tamaulipas and in the Gulf of Mexico in general (NMFS and USFWS 2007b).

In this Opinion, we have considered the potential impacts of the proposed action on Kemp's ridley sea turtles. We expect the capture of up to 95 Kemp's ridleys during the proposed actions over the next five years. Fifteen Kemp's ridleys in total over the five-year period have the potential to be seriously injured or killed.

Capture during the proposed actions will temporarily prevent these sea turtles from carrying out essential behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the turtles are returned to the water. The capture of live Kemp's ridley sea turtles is not likely to reduce the numbers of Kemp's ridley sea turtles in the action area, the numbers of Kemp's ridley sea turtles in any subpopulation or the species as a whole. Similarly, as the capture of live Kemp's ridley sea turtles will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live Kemp's ridley sea turtles is also not likely to affect the distribution of Kemp's ridley sea turtles in the action area or affect the distribution of sea turtles throughout their range. As any effects to individual live Kemp's ridley sea turtles temporarily removed from the water will be minor and temporary there are not anticipated to be any population level impacts.

The mortality of fifteen Kemp's ridleys over five years represents a very small percentage of the Kemp's ridleys worldwide. Even taking into account just nesting females, the death of fifteen Kemp's ridley represents less than 0.2% of the population. While the death of fifteen Kemp's ridleys will reduce the number of Kemp's ridleys compared to the number that would have been present absent the proposed actions, it is not likely that this reduction in numbers will change the status of this species or its stable to increasing trend as this loss represents a very small percentage of the population (less than 0.2%). Reproductive potential of Kemp's ridleys is not expected to be affected in any other way other than through a reduction in numbers of individuals. A reduction in the number of Kemp's ridleys would have the effect of reducing the amount of potential reproduction as any dead Kemp's ridleys would have no potential for future reproduction. In 2006, the most recent year for which data is available, there were an estimated 7,000-8,000 nesting females. While the species is thought to be female biased, there are likely to be several thousand adult males as well. Given the number of nesting adults, it is unlikely that the loss of fifteen Kemp's ridleys over five years would affect the success of nesting in any year. Additionally, this small reduction in potential nesters is expected to result in a small reduction in the number of eggs laid or hatchlings produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future nesters that would be produced by the individuals that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be very small and would not change the stable to increasing trend of this species. Additionally, the proposed actions will not affect nesting beaches in any way or disrupt migratory movements in a way that hinders access to nesting beaches or otherwise delays nesting.

The proposed actions are not likely to reduce distribution because the actions will not impede Kemp's ridleys from accessing foraging grounds or cause more than a temporary disruption to other migratory behaviors. Additionally, given the small percentage of the species that will be killed as a result of the surveys and studies, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity.

Generally speaking, while the loss of a small number of individuals from a subpopulation or species may result in an appreciable reduction in the total numbers, reproduction, and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range, or the species has extremely low levels of genetic diversity. This situation is not likely in the case of Kemp's ridleys because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population, and the number of Kemp's ridleys is likely to be increasing and at worst is stable.

Based on the information provided above, the death of fifteen Kemp's ridley sea turtles over the next five years will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect Kemp's ridleys in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent Kemp's ridleys from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the species' nesting trend is increasing; (2) the death of fifteen Kemp's ridleys over five years represents an extremely small percentage of the species as a whole; (3) the loss of these Kemp's ridleys will not change the status or trends of the species as a whole; (4) the loss of these Kemp's ridleys is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of these Kemp's ridleys is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (6) the actions will have only a minor and temporary effect on the distribution of Kemp's ridleys in the action area and no effect on the distribution of the species throughout its range; and (7) the actions will have no effect on the ability of Kemp's ridleys to shelter and only an insignificant effect on individual foraging Kemp's ridleys.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that Kemp's ridley sea turtles will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that Kemp's ridleys can rebuild to a point where listing is no longer appropriate. In 2011, NMFS and the USFWS issued a recovery plan for Kemp's ridleys (NMFS and USFWS 2011). The plan includes a list of criteria necessary for recovery. These include:

1. An increase in the population size, specifically in relation to nesting females[12];
2. An increase in the recruitment of hatchlings[13];
3. An increase in the number of nests at the nesting beaches;
4. Preservation and maintenance of nesting beaches (e.g., Rancho Nuevo, Tepehuajes, and Playa Dos); and,
5. Maintenance of sufficient foraging, migratory, and inter-nesting habitat.

Kemp's ridleys have an increasing trend; as explained above, the loss of fifteen Kemp's ridleys over five years during the proposed actions will not affect the population trend. The number of Kemp's ridleys likely to die as a result of the proposed action is an extremely small percentage of the species. This loss will not affect the likelihood that the population will reach the size necessary for recovery or the rate at which recovery will occur. As such, the proposed actions will not affect the likelihood that criteria one, two or three will be achieved or the timeline on which they will be achieved. The action area does not include nesting beaches; therefore, the proposed actions will have no effect on the likelihood that recovery criteria four will be met. All effects to habitat will be insignificant and discountable; therefore, the proposed actions will have no effect on the likelihood that criteria five will be met.

The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery and the action will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of Kemp's ridleys and a small reduction in the amount of potential reproduction due to the loss of fifteen individuals over a five-year period, these effects will be undetectable over the long-term and the action is not expected to have long term impacts on the future growth of the population or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions will not appreciably reduce the likelihood that Kemp's ridley sea turtles can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual Kemp's ridley sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the

[12] A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches in Mexico (Rancho Nuevo, Tepehuajes, and Playa Dos) is attained in order for downlisting to occur; an average of 40,000 nesting females per season over a 6-year period by 2024 for delisting to occur.

[13] Recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches in Mexico (Rancho Nuevo, Tepehuajes, and Playa Dos).

potential mortality of up to fifteen Kemp's ridley sea turtles over the next five years of NEFSC research, is not likely to appreciably reduce the survival and recovery of this species.

8.4 North Atlantic DPS of Green Sea Turtles

The North Atlantic DPS of green sea turtles is listed as threatened under the ESA. As is also the case with the other sea turtle species, North Atlantic DPS green sea turtles face numerous threats on land and in the water that affect the survival of all age classes.

The greatest abundance of green sea turtle nesting in the North Atlantic occurs on beaches in Tortuguero, Costa Rica (NMFS and USFWS 2007c). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007c).

The results of genetic analyses show that green sea turtles in the Atlantic do not contribute to green sea turtle nesting elsewhere in the species' range (Bowen and Karl 2007). Therefore, increased nesting by green sea turtles in the Atlantic is not expected to affect green sea turtle abundance in other ocean basins in which the species occurs. NMFS recognizes that the nest count data available for green sea turtles in the Atlantic clearly indicates increased nesting at many sites. However, NMFS also recognizes that the nest count data, including data for green sea turtles in the Atlantic, only provides information on the number of females currently nesting, and is not necessarily a reflection of the number of mature females available to nest or the number of immature females that will reach maturity and nest in the future. Given the late age to maturity for green sea turtles (20 to 50 years) (Balazs 1982; Frazer and Ehrhart 1985; Seminoff 2004), caution is urged regarding the trend for any of the nesting groups since no area has a dataset spanning a full green sea turtle generation (NMFS and USFWS 2007c).

In this Opinion, we have considered the potential impacts of the proposed actions on green sea turtles. We expect that up to ten green sea turtles will be captured as a result of the proposed actions in the next five years. The ten captured green sea turtles will be released alive and uninjured. As there will be no injury or mortality to any individual green sea turtle and no effects to the prey base that would cause sea turtles to leave the action area to forage elsewhere, the proposed actions are not likely to reduce the numbers of green sea turtles in the action area or the DPS as a whole. The proposed actions will have no effects to the prey base that would cause sea turtles to leave the action area to forage elsewhere and the green sea turtle's numbers in the action area and as part of any subpopulation as a whole will not be reduced. Similarly, as the proposed actions will not affect the fitness of any individuals, no effects to reproduction are anticipated. The actions are not expected to result in a reduction in the distribution of green sea turtles in the action area or throughout their range. Because effects are limited to capture, the population level impacts will be insignificant. Despite the threats faced by individual green sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. While we are not able to predict with precision how climate change will continue to impact green sea turtles in the action area or how the species will adapt to climate-change related environmental impacts, no additional effects related to climate change to green sea turtles in the action area are anticipated over the life of the proposed actions (i.e., over the next five years). We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

As described in the *Status of the Species*, *Environmental Baseline*, and *Cumulative Effects* sections above, green sea turtles in the action area continue to be affected by multiple anthropogenic impacts including bycatch in commercial and recreational fisheries, habitat alteration and other factors that result in mortality of individuals at all life stages.

Based on the information provided above, the capture of up to ten green sea turtles during the proposed actions over the next five years will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect green sea turtles in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent green sea turtles from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the species' nesting trend is increasing; (2) no mortalities are expected as a result of capture; (3) the actions will have no effect on the distribution of green sea turtles in the action area or throughout its range; and (4) the actions will have no effect on the ability of green sea turtles to shelter and only a minor and temporary effect on individual foraging green sea turtles.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that green sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the species can rebuild to a point where listing is no longer appropriate. A recovery plan for green sea turtles was published by NMFS and USFWS in 1991. The plan outlines the steps necessary for recovery and the criteria which, once met, would ensure recovery. In order to be delisted, green sea turtles must experience sustained population growth, as measured in the number of nests laid per year, over time. Additionally, "priority one" recovery tasks must be achieved and nesting habitat must be protected (through public ownership of nesting beaches) and stage class mortality must be reduced. Here, we consider whether this proposed action will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions will not appreciably reduce the likelihood of survival of green sea turtles. Also, they are not expected to modify, curtail, or destroy the range of the species since they will not cause any reductions in the number of green sea turtles in any geographic area and since they will not affect the overall distribution of green sea turtles other than to cause minor temporary adjustments in movements in the action area. As explained above, the proposed actions are not likely to result in mortality, and thus are not expected to affect the persistence of green sea turtles or the species trend. The actions will not affect nesting habitat and will not hasten the extinction timeline or otherwise increase the danger of extinction. Further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. Therefore, based on the analysis presented above, the proposed actions will not appreciably reduce the likelihood that green sea turtles can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual green sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the capture of up to ten green sea turtles over five years, is not likely to appreciably reduce the survival and recovery of this species.

8.5 Leatherback Sea Turtles

Leatherback sea turtles are listed as "endangered" under the ESA. Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, Mediterranean Sea, and the Gulf of Mexico (Ernst and Barbour 1972). Leatherback nesting occurs on beaches of the Atlantic, Pacific, and Indian Oceans as well as in the Caribbean (NMFS and USFWS 2007d). Leatherbacks face a multitude of threats that can cause death prior to and after reaching maturity. Some activities resulting in leatherback mortality have been addressed. There are some population estimates for leatherback sea turtles although there appears to be considerable uncertainty in the numbers. The most recent population size estimate for the North Atlantic alone is 34,000-94,000 adult leatherbacks (TEWG 2007; NMFS and USFWS 2007d).

Leatherback nesting in the eastern Atlantic (i.e., off Africa) and in the Caribbean appears to be stable, but there is conflicting information for some sites and it is certain that some nesting groups (e.g., St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS 1995). Data collected for some nesting beaches in the western Atlantic, including leatherback nesting beaches in the U.S., clearly indicate increasing numbers of nests (SEFSC 2001; NMFS and USFWS 2007d). However, declines in nesting have been noted for beaches in the western Caribbean (NMFS and USFWS 2007d). The largest leatherback rookery in the western Atlantic remains along the northern coast of South America in French Guiana and Suriname. More than half the present world leatherback population is estimated to nest on the beaches in and close to the Marowijne River Estuary in Suriname and French Guiana (Hilterman and Goverse 2004). The long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). Studies by Girondot *et al.* (2007) also suggest that the trend for the Suriname - French Guiana nesting population over the last 36 years is stable or slightly increasing.

Increased nesting by leatherbacks in the Atlantic is not expected to affect leatherback abundance in the Pacific where the abundance of leatherback sea turtles on nesting beaches has declined dramatically over the past 30 years (NMFS and USFWS 2007d). Although genetic analyses suggest little difference between Atlantic and Pacific leatherbacks (Bowen and Karl 2007), it is generally recognized that there is little to no genetic exchange between these turtles.

In this Opinion, we have considered the potential impacts of the proposed actions on leatherback sea turtles. We anticipate that up to ten leatherbacks will be captured in the proposed actions over the next five years. Five of the captured leatherbacks are expected to be safely removed from the gear being used and returned to the ocean without any injury or mortality, while the other five are expected to suffer serious injury or mortality. All other effects to leatherback sea turtles, including effects to prey, are expected to be insignificant and discountable.

As there will be injury or mortality to only five individual leatherback sea turtles over a five-year period and no effects to the prey base that would cause sea turtles to leave the action area to forage elsewhere, the proposed actions are not likely to significantly reduce the numbers of leatherback sea turtles in the action area, the numbers of leatherbacks in any subpopulation, or the species as a whole. In addition, the surveys will cause no effects to the prey base that would cause sea turtles to leave the action area to forage elsewhere and the leatherbacks sea turtle's numbers in the action area and as part of any subpopulation as a whole will not be reduced. Similarly, as the proposed actions will affect the fitness of only a few individuals, little to no effects on reproduction are anticipated. The actions are also not likely to affect the distribution of leatherback sea turtles in the action area or affect the distribution of leatherback sea turtles throughout their range. Despite the threats faced by individual leatherback sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. While we are not able to predict with precision how climate change will continue to impact leatherback sea turtles in the action area or how the species will adapt to climate-change related environmental impacts, no additional effects related to climate change to leatherback sea turtles in the action area are anticipated over the life of the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

Based on the information provided above, the serious injury/mortality of up to five leatherback sea turtles during the proposed actions over a five-year period will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species). The actions will not affect leatherbacks in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent leatherbacks from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of five leatherbacks over five years represents an extremely small percentage of the species as a whole; (2) the loss of these leatherbacks will not change the status or trends of any nesting aggregation, recovery unit, or the species as a whole; (3) the loss of these leatherbacks is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these leatherbacks is likely to have an undetectable effect on reproductive output of any nesting aggregation or the species as a whole; (5) the actions will have no effect on the distribution of leatherbacks in the action area or throughout its range; and (6) the actions will have no effect on the ability of leatherbacks to shelter and only an insignificant effect on individual foraging leatherbacks.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the leatherback sea turtle species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

The proposed actions are not expected to modify, curtail, or destroy the range of the species since it will not result in a significant reduction in the number of leatherback sea turtles and since it will not affect the overall distribution of the species other than to cause minor temporary adjustments in movements in the action area. The proposed actions will not use leatherback sea turtles for recreational, scientific, or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed actions are not likely to result in any reductions in fitness or future reproductive output and therefore, are not expected to affect the persistence of the species. There will not be a change in the status or trend of the species. As there will be only a minor reduction in future reproduction, the actions would not cause any reduction in the likelihood of improvement in the status of leatherback sea turtles. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the actions will not cause any reduction of overall reproductive fitness for the species. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that leatherback sea turtles can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

8.6 Shortnose Sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers. Population sizes range from under

100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for five of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson, and possibly the Delaware and Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

The NEFSC proposes to conduct or fund several studies within nearshore/estuarine areas of the action area such as the Penobscot and Hudson River estuaries using non-selective gear types (trawls and potentially seines and fyke nets). As explained in the *Effects of the Action* section, the deployment of those gear types is likely to result in interactions with a limited number of shortnose sturgeon. NMFS has estimated that the proposed actions will result in up to ten captures and one mortality over the next five years. The potential for effects are possible when fish encounter or are trapped by the sampling gear. These effects could range from altering normal behavior such as a temporary startle or avoidance of the sampling area or result in minor physiological stress and minor physical injury from abrasion associated with physically interacting with the trap, main lead or wings. Non-lethal behavioral responses are expected to be temporary and spatially limited to the area and time fish interact with or are restricted by sampling gear. Capture in sampling gear is anticipated to increase physiological effects associated with handling stress and result in minor injuries that for the majority will not impair the fitness of any individuals or affect survival, however a small percentage could suffer lethal injuries or death. We have determined that any behavioral responses from fish passively interacting with the sampling gear, including in the worst case, an increase in physiological stress associated with physically interacting with the leads, would have insignificant and discountable effects to individuals. We have further determined the behavior and physiological responses as a result of sturgeon becoming captured; would increase physiological stress (i.e., associated with physically removing the animal from the trap) and cause physical injury, which could result in mortality. Therefore, the survival of up to one individual shortnose sturgeon will be affected by the proposed actions during the five-year span of the Opinion. As such, there will be a slight reduction in the numbers of shortnose sturgeon, yet no change in the status of the species or its trend.

Shortnose sturgeon captured in trawl, beach seine, or fyke net gear will experience a disruption in normal behavior for up to 30 minutes and may experience physical injury that may lead to death. As outlined above, no more than ten shortnose sturgeon are likely to become captured in these types of net gear over the course of five years. While precautions will be taken to minimize handling stress, physical injuries due to being captured by net gear could result in lethal injury or mortality. Data from commercial trawling indicates a low mortality rate of shortnose sturgeon incidentally caught in otter trawl gear. Interactions between shortnose sturgeon and beach seines are anticipated to be very brief in duration (<20 minutes) and limited to the immediate area of the net set. Because shortnose sturgeon could become captured in this gear, protocols will be in place to expedite release and reduce stress from handling. Adverse effects may also result from interactions with the fyke nets. Specifically, shortnose sturgeon encountering the fyke nets may become trapped within the fyke net until the net is tended and the catch is processed and released. This will result in the disruption of normal behaviors for a maximum of 24 hours.

While fyke net sampling is generally considered to be non-lethal, there is the potential for sturgeon to become trapped or entangled in the gear or otherwise suffer lethal injury or mortality. However, the mortality rate is expected to be very low.

While the proposed sampling may result in the mortality of one shortnose sturgeon, this number represents a very small percentage of shortnose sturgeon in the action area, and an even smaller percentage of the total population of shortnose sturgeon range-wide. It is also important to note that this mortality estimate is considered to be a worst case scenario and is based on conservative assumptions outlined in the *Effects of the Action* section above as well as in our past Opinion on net sampling surveys in the Penobscot River estuary (NMFS 2012b). While the death of one adult shortnose sturgeon will reduce the number of shortnose sturgeon in the action area compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population as this loss represents an extremely small percentage of fish residing in the action area.

The proposed actions are expected to cause an undetectable reduction in reproduction of shortnose sturgeon for the following reasons: (1) the proposed research projects are not likely to intercept any pre-spawning shortnose sturgeon; thus, there will be no delay in migration to the spawning grounds; (2) at worst, the actions will result in the mortality of one adult shortnose sturgeon, as there are many thousands of available spawners in the action area rivers, the reduction in available spawners by no more than one is expected to result in an undetectable reduction in the number of eggs laid or larvae produced and similarly, an undetectable effect on the strength of subsequent year classes. Additionally, the proposed actions will not affect spawning habitats in any way and will not create any barrier to pre-spawning sturgeon accessing their spawning grounds. The proposed action is not likely to reduce distribution because the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon or the ability of shortnose sturgeon to migrate between coastal rivers. Additionally as the number of shortnose sturgeon likely to be killed as a result of the proposed action is extremely small, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity. While generally speaking, the loss of one individual from a subpopulation or species may have an appreciable effect on the numbers, reproduction, and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range, or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: (1) the species is widely geographically distributed; (2) it is not known to have low levels of genetic diversity (see *Status of Listed Species* section above); and (3) there are thousands of shortnose sturgeon spawning each year.

Based on the information provided above, the death of no more than one shortnose sturgeon as a result of the proposed actions will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for this species given that: (1) the death of one shortnose sturgeon represents an extremely small percentage of the number of shortnose sturgeon in the action area and even a smaller percentage of the species as a whole; (2) the loss of one shortnose sturgeon will not change the status or trends of the species as a whole; (3) the loss of one shortnose sturgeon is likely to have an undetectable effect on reproductive output of the species as a whole; (4) and, the action will have no effect on the distribution of shortnose sturgeon in the action area or throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(l) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five ESA listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, and (5) other natural or manmade factors affecting its continued existence.

The proposed actions are not expected to modify, curtail, or destroy the range of the species since it will result in only a slight reduction in the number of shortnose sturgeon and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements within the action area. The proposed actions will not utilize shortnose sturgeon for recreational or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed actions are likely to result in up to one mortality, a slight reduction in future reproductive output; therefore, the NEFSC's fisheries and ecosystem research is not expected to affect the persistence of shortnose sturgeon range-wide. There will be no change in the status or trend of shortnose sturgeon. As there will be only a slight reduction in numbers or future reproduction, the actions would not cause any reduction in the likelihood of improvement in the status of shortnose sturgeon. The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction since the actions will not cause any significant reduction of overall reproductive fitness for the species. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

8.7 Atlantic Sturgeon

As explained above, the proposed actions are likely to result in the capture of up to 119 Atlantic sturgeon annually, or 595 interactions over the next five years. We expect that the Atlantic sturgeon captured will be of adult or subadult life stages. No capture of eggs, larvae, or juveniles is anticipated. All other effects to Atlantic sturgeon, including effects from vessel traffic and effects to habitat and prey resources due to fisheries and ecosystem research activities, will be insignificant and discountable.

8.7.1 Determination of DPS Composition

Using mixed stock analysis explained above, we have determined that Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: NYB 51.7%; SA 21.9%; CB 11.8%; GOM 10.1%; and Carolina 2.4%. As a result of the proposed actions, given the above percentages, it is most likely that of the 595 total Atlantic sturgeon interactions over a five-year period, 308 would be fish that originate from the NYB DPS, 130 would be fish originating from the SA DPS, 70 would be fish originating from the CB DPS, 60 would be fish originating from the GOM DPS, 14 would be a fish originating from the Carolina DPS, and 13 would be fish of Canadian origin (non-listed).

8.7.2 Gulf of Maine DPS

The GOM DPS is listed as threatened. While Atlantic sturgeon occur in several rivers in the Gulf of Maine region, recent spawning has only been documented in the Kennebec; spawning is suspected to also occur in the Androscoggin River. No estimate of the number of Atlantic sturgeon in any river or for any life stage or the total population is available although the ASSRT stated that there were likely less than 300 spawners per year. GOM origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. While there are some indications that the status of the GOM DPS may be improving, there is currently not enough information to establish a trend for any life stage or for the DPS as a whole.

We have estimated that the proposed actions will result in the capture of 595 or fewer Atlantic sturgeon over a five-year period, of which up to 60 are expected to be GOM DPS Atlantic sturgeon. We anticipate the mortality of only three individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated.

With the exception of a small percentage of Atlantic sturgeon captured in trawl surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gillnets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. The short duration of any capture and handling (i.e., less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to three Atlantic sturgeon over a five-year period from the GOM DPS. The reproductive potential of the GOM DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to three individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead GOM DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where GOM DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by GOM DPS fish.

Because we do not have a population estimate for the GOM DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than three individuals over a five-year period, and there is unlikely to be more than one mortality each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the GOM DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by GOM DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to three GOM DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the GOM DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect GOM DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one GOM DPS Atlantic sturgeon in any year and the total loss of up to three individuals will not change the status or trends of the species as a whole; (2) the death of these GOM DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these GOM DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these GOM DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of GOM DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of GOM DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging GOM DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the GOM DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the GOM DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the GOM DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of GOM DPS Atlantic sturgeon and since it will not affect the overall distribution of GOM DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality (three individuals over five years) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the GOM DPS of Atlantic sturgeon. These actions will not change the status or trend of the GOM DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the GOM DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual GOM DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to three GOM DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species

8.7.3 New York Bight DPS

Individuals originating from the NYB DPS are reasonably likely to occur in the action area. The NYB DPS is listed as endangered. While Atlantic sturgeon occur in several rivers in the NYB DPS, recent spawning has only been documented in the Hudson and Delaware Rivers. The capture of age 0 Atlantic sturgeon in the Connecticut River in 2014 indicates that spawning may also occur in this river. However, as these young sturgeon represent the only evidence of spawning since the population began being studied in the 1980s, and we do not have any information on the genetic identity of these individuals, we do not know if these represent a unique Connecticut River population or were spawned by migrants from the Hudson River. Based on existing data, we expect any NYB DPS Atlantic sturgeon in the action area to originate from the Delaware or Hudson River. There is limited information on the demographics of the Hudson River population of Atlantic sturgeon. Spawning still occurs in the Delaware, however, this are no abundance estimates for the Delaware River population of Atlantic sturgeon (ASSRT, 2007). An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007). As discussed in Section 4.2, the NEAMAP based methodology estimates a total of 34,566 sub-adult and adult NYB DPS Atlantic sturgeon in the ocean.

No data on abundance of juveniles are available prior to the 1970s; however, catch depletion analysis estimated conservatively that 6,000-6,800 females contributed to the spawning stock during the late 1800s (Secor 2002, Kahnle *et al.* 2005). Two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately six year classes, excluding young of year.

In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and 14 wild age-1 Atlantic sturgeon (Peterson *et al.* 2000). A Petersen mark-recapture population estimate from these data suggests that there were 9,529 (95% CI = 1,916-10,473) age-0 Atlantic sturgeon in the estuary in 1994. Since 4,929 were stocked, 4,600 fish were of wild origin, assuming equal survival for both hatchery and wild fish and that stocking mortality for hatchery fish was zero.

Information on trends for Atlantic sturgeon in the Hudson River are available from a number of long term surveys. From July to November during 1982-1990 and 1993, the NYSDEC sampled the abundance of juvenile fish in Haverstraw Bay and the Tappan Zee Bay. The CPUE of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since this time.

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which are collected from May-July, provide an annual index of juvenile Atlantic sturgeon in the Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July-October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early 1990s. While the amount of interannual variability makes it difficult to detect short term trends, a five year running average of CPUE from the FJS indicates a slowly increasing trend since about 1996. Interestingly, that is when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003-2005, 579 juveniles were collected (N = 122, 208, and 289, respectively) (Sweka et al. 2006). Pectoral spine analysis showed they ranged from 1-8 years of age, with the majority being ages 2-6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles.

NYB DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. A bycatch estimate provided by NEFSC indicates that approximately 376 Atlantic sturgeon die as a result of bycatch each year. Because juveniles do not leave the river, they are not impacted by fisheries occurring in Federal waters. Bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (shad), has now been closed and there is no indication that it will reopen soon. NYB DPS Atlantic sturgeon are killed as a result of anthropogenic activities in the Hudson River and other rivers; sources of potential mortality include vessel strikes and entrainment in dredges.

We have estimated that the proposed actions will result in the capture of 595 or fewer Atlantic sturgeon over a five-year period, of which up to 308 are expected to be NYB DPS Atlantic sturgeon. We anticipate the mortality of only 15 individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated. Effects are anticipated when fish encounter or are trapped by the survey gear. These effects consist of alterations in normal behavior, such as a temporary startle or avoidance of the sampling area; minor physiological stress; and minor physical injury from abrasion associated with physically interacting with the trap, main lead or wings. Non-lethal behavioral responses are expected to be temporary and spatially limited to the area and time fish interact with or are restricted by survey gear.

With the exception of a small percentage of Atlantic sturgeon captured in trawl surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gillnets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. The short duration of any capture and handling (i.e., less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to fifteen Atlantic sturgeon over a five-year period from the NYB DPS. The reproductive potential of the NYB DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to fifteen individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead NYB DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where NYB DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by NYB DPS fish.

Because we do not have a population estimate for the NYB DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than fifteen individuals over a five-year period, and there is unlikely to be more than three mortalities each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the NYB DPS.

Based on the information provided above, the death of up to fifteen NYB DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the NYB DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect NYB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of these NYB DPS Atlantic sturgeon over a five-year period represents an extremely small percentage of the species as a whole; (2) the death of these NYB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these NYB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these NYB DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of NYB DPS Atlantic sturgeon to shelter and only an insignificant effect on individual foraging NYB DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the NYB DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the NYB DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the NYB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether these proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions are not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of NYB DPS Atlantic sturgeon and since it will not affect the overall distribution of NYB DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in a small amount of mortality (no more than fifteen individual over five years) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the NYB DPS of Atlantic sturgeon. These actions will not change the status or trend of the NYB DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the NYB DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened.

Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual NYB DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to fifteen NYB DPS Atlantic sturgeon over a five-year period, is not likely to appreciably reduce the survival and recovery of this species.

8.7.4 Chesapeake Bay DPS

We have estimated that the proposed actions will result in the capture of 595 or fewer Atlantic sturgeon over a five-year period, of which up to 70 are expected to be CB DPS Atlantic sturgeon. We anticipate the mortality of only four individuals over the next five years; no injury or mortality of any other captured Atlantic sturgeon is anticipated.

The CB DPS is listed as endangered. While Atlantic sturgeon occur in several rivers in the CB DPS, recent spawning has only been documented in the James River. Chesapeake Bay DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. Chesapeake Bay origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently not enough information to establish a trend for any life stage, for the James River spawning population or for the DPS as a whole.

With the exception of a small percentage of Atlantic sturgeon captured in trawl surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gillnets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. The short duration of any capture and handling (i.e., less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to four Atlantic sturgeon over a five-year period from the CB DPS. The reproductive potential of the CB DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to four individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead CB DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where CB DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by CB DPS fish.

Because we do not have a population estimate for the CB DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than four individuals over a five-year period, and there is unlikely to be more than one mortality each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the CB DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by CB DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to four CB DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the CB DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect CB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one CB DPS Atlantic sturgeon in any year and the total loss of up to four individuals will not change the status or trends of the species as a whole; (2) the death of these CB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these CB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these CB DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of CB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of CB DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging CB DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the CB DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the CB DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the CB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of CB DPS Atlantic sturgeon and since it will not affect the overall distribution of CB DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality over the next five years and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the CB DPS of Atlantic sturgeon. These actions will not change the status or trend of the CB DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the CB DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the CB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual CB DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to four CB DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species.

8.7.5 Carolina DPS

We have estimated that the proposed actions will result in the capture of 595 or fewer Atlantic sturgeon over a five-year period, of which up to 14 are expected to be Carolina DPS Atlantic sturgeon. We anticipate the mortality of only one individual over five years; no injury or mortality of any other captured Atlantic sturgeon is anticipated.

The Carolina DPS is listed as endangered. The Carolina DPS consists of Atlantic sturgeon originating from at least five rivers where spawning is still thought to occur. Carolina DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range.

With the exception of a small percentage of Atlantic sturgeon captured in trawl surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gill nets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. The short duration of any capture and handling (i.e., less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to one Atlantic sturgeon over a five-year period from the Carolina DPS. The reproductive potential of the Carolina DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to one individual over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead Carolina DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where Carolina DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by Carolina DPS fish.

Because we do not have a population estimate for the Carolina DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than one individual over a five-year period, it is unlikely that this death will have a detectable effect on the numbers and population trend of the Carolina DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by Carolina DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to one Carolina DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the Carolina DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect Carolina DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one Carolina DPS Atlantic sturgeon in any year and the total loss of up to one individual over five years will not change the status or trends of the species as a whole; (2) the death of this Carolina DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of this Carolina DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of this Carolina DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of Carolina DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of Carolina DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging Carolina DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the CA DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the CA DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the CA DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food.

Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of Carolina DPS Atlantic sturgeon and since it will not affect the overall distribution of Carolina DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality over five years (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the Carolina DPS of Atlantic sturgeon. These actions will not change the status or trend of the Carolina DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the Carolina DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the Carolina DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual Carolina DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to one Carolina DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species.

8.7.6 South Atlantic DPS

We have estimated that the proposed actions will result in the capture of 595 or fewer Atlantic sturgeon over a five-year period, of which up to 130 are expected to be SA DPS Atlantic sturgeon. We anticipate the mortality of only seven individuals over the next five years; no injury or mortality of any other captured Atlantic sturgeon is anticipated.

The SA DPS is listed as endangered. The SA DPS consists of Atlantic sturgeon originating from at least six rivers where spawning is still thought to occur. Schueller and Peterson (2006) estimate that there were 343 adults spawning in the Altamaha River, Georgia in 2004 and 2005. This represents a percentage of the total adult population for the Altamaha River. Males spawn every 1-5 years and females spawn every 2-5 years; thus, the total Altamaha River adult population, assuming a 2:1 ratio of males: females as seen on the Hudson River, could range from 457-1,715. Spawning occurs in at least five other rivers in this DPS, thus the number of

Atlantic sturgeon in the Altamaha River population is only a portion of the total DPS. No estimate of the number of Atlantic sturgeon in any of the other spawning rivers or for the DPS as a whole is available.

With the exception of a small percentage of Atlantic sturgeon captured in trawl surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gillnets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. The short duration of any capture and handling (i.e., less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to seven Atlantic sturgeon over a five-year period from the SA DPS. The reproductive potential of the SA DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to seven individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead SA DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where SA DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by SA DPS fish.

Because we do not have a population estimate for the SA DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than seven individuals over a five-year period, and there is unlikely to be more than one or two mortalities each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the SA DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by SA DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to seven SA DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the SA DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect SA DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one or two SA DPS Atlantic sturgeon in any year and the total loss of up to seven individuals will not change the status or trends of the species as a whole; (2) the death of these SA DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these SA DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these SA DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of SA DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of SA DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging SA DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the SA DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the SA DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the SA DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of SA DPS Atlantic sturgeon and since it will not affect the overall distribution of SA DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality annually (one or two individuals) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the SA DPS of Atlantic sturgeon. These actions will not change the status or trend of the SA DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the SA DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the SA DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual SA DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to seven SA DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species.

8.8 Gulf of Maine DPS of Atlantic Salmon

Albeit on rare occasions, Atlantic salmon have been observed to interact with gear used in the NEFSC's fisheries and ecosystem research in the past. An Atlantic salmon was most recently captured during the 2012 NEFSC spring bottom trawl surveys; upon capture it was released alive. Prior to that, two other Atlantic salmon were captured back in the late 1970s: one during the NEFSC fall bottom trawl surveys on the NOAA ship *Delaware II* in September 1977 and another during a foreign research bottom trawl winter survey in January 1978. In addition, from 1989-2014, there were four observed captures of Atlantic salmon in commercial bottom otter trawl gear and 11 observed captures in gillnet gear in the New England and Mid-Atlantic regions (NEFOP and ASM databases). Based on these records, we anticipate up to one Atlantic salmon interaction will occur annually as a result of the proposed actions (for a total of five interactions over the next five years), with two interactions every five years anticipated to be lethal.

Gulf of Maine DPS smolts generally enter the sea in May, and follow direct routes out of the coastal environment into the ocean (Hyvarinen *et al*. 2006; Lacroix and McCurdy 1996; Lacroix *et al*. 2004, 2005). Studies suggest that post-smolts move near the coast in migration corridors closely related to surface currents (Hyvarinen *et al*. 2006; Lacroix and McCurdy 1996; Lacroix *et al*. 2004, 2005). North American post-smolts appear to have a near-shore distribution (Friedland *et al*. 2003), and move to the Labrador Sea and off of the west coast of Greenland in the late summer to autumn of their first year (Reddin 1985; Reddin and Short 1991; Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and MSW fish, and includes immature salmon from both North American and European stocks (Reddin

1988; Reddin *et al.* 1988). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985; Dutil and Coutu 1988; Ritter 1989; Reddin and Friedland 1993; and Friedland *et al.* 1999). Some salmon may remain at sea for another year or more before maturing, overwintering in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Part of their migratory pattern overlaps with the action area at times when the seven fisheries are active.

Two lethal takes are expected to occur every five years as a result of the proposed actions. Lethal interactions would reduce the number of Gulf of Maine DPS Atlantic salmon, compared to their numbers in the absence of the proposed actions, assuming all other variables remained the same. Lethal interactions would also result in a potential reduction in future reproduction, assuming the individuals may be female and would have otherwise survived to reproduce. For example, an adult 2SW female Atlantic salmon can produce a total of 1,500 to 1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs (Baum and Meister 1971), of which a small percentage is expected to survive to sexual maturity. Two lethal captures of adult female Gulf of Maine DPS Atlantic salmon would likely remove this level of reproductive output from the species. The anticipated lethal interactions are expected to occur anywhere in the action area, though are most likely to occur in the Gulf of Maine and Georges Bank areas. Whether the reduction in numbers and reproduction of this species would appreciably reduce its likelihood of survival depends on the probable effect the change in numbers and reproduction would have relative to current population sizes and trends.

The most recent data available on the population trend of Atlantic salmon indicate that their abundance within the range of the Gulf of Maine DPS has been generally declining since the 1800s (Fay *et al.* 2006). Contemporary estimates of abundance for the entire Gulf of Maine DPS have rarely exceeded 5,000 individuals in any given year since 1967 (Fay *et al.* 2006), and appear to have stabilized at very low levels since 2000. After a period of slow population growth between the 1970s and the early 1980s, adult returns of salmon in the Gulf of Maine DPS peaked around 1985 and declined through the 1990s and early 2000s. Adult returns have been increasing again over the last few years. The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH that was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the Gulf of Maine DPS remained relatively stable until the early 1990s. In the early 1990s, marine survival rates decreased, leading to the declining trend in adult abundance observed throughout 1990s and early 2000s. The increase in the abundance of returning adult salmon observed between 2008 and 2011 may be an indication of improving marine survival.

Adult returns for the Gulf of Maine DPS remain well below conservation spawning escapement (CSE) goals that are widely used to describe the status of individual Atlantic salmon populations (ICES 2005). When CSE goals are met, Atlantic salmon populations are generally self-sustaining. When CSE goals are not met (i.e., less than 100%), populations are not reaching full potential; and this can be indicative of a population decline. For all Gulf of Maine DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below

CSE levels required to sustain themselves (Fay *et al.* 2006), which is further indication of their poor population status.

The observed declines in Atlantic salmon suggests that the combined impacts from ongoing activities described in the *Environmental Baseline*, *Cumulative Effects*, and the *Status of Listed Species* (including those activities that occur outside of the action area of this Opinion) are continuing to cause the population to deteriorate.

We believe the proposed actions are not reasonably expected to cause, directly or indirectly, an appreciable reduction in the likelihood of survival of the Gulf of Maine DPS of Atlantic salmon. For the population to remain stable, Atlantic salmon must replace themselves through successful reproduction at least once over the course of their reproductive lives, and at least one offspring must survive to reproduce itself. If the survival rate to maturity is greater than the mortality rate of the population, the loss of breeding individuals would be exceeded through recruitment of new breeding individuals from successful reproduction of Atlantic salmon that were not seriously injured or killed by the proposed actions. While the abundance trend information for Atlantic salmon is either stable or declining, we believe the small number of lethal interactions attributed to the proposed actions will not have any measurable effect on that trend.

As also described in the *Environmental Baseline*, a number of actions are being taken to help Atlantic salmon recover. These include hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to Atlantic salmon and developing effective recovery strategies.

The 2010 recovery framework for Atlantic salmon has as its objectives to increase abundance, distribution, ecosystem function, and genetic diversity of the species. To support these objectives, a five-prong strategy was developed:

Strategy A: Increase Marine and Estuarine Survival
Strategy B: Increase Connectivity
Strategy C: Maintain Genetic Diversity through the Conservation Hatchery
Strategy D: Increase Adult Spawners through the Conservation Hatchery
Strategy E: Increase Adult Spawners through the Freshwater Production of Smolts

Improving the survival of Atlantic salmon in the marine environment is an important part of meeting the objective of Gulf of Maine DPS Atlantic salmon recovery. The species is currently at a state where recovery will be extremely difficult due to poor marine and freshwater survival rates; however, we do not believe that the proposed actions would appreciably reduce the species' likelihood for recovery for the following reasons. First, there would only be a very small reduction in the number of returning adults and their reproductive success. Second, for the fish in which lethal take is not anticipated, we anticipate no lasting effects on their ability to survive and reproduce. Lastly, the information collected through a number of these fisheries and ecosystem studies will be used to inform future management decisions that could potentially increase the likelihood for recovery. Therefore, the proposed actions will not affect Atlantic salmon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic salmon from completing their entire life cycle, including reproduction, sustenance, and shelter. Therefore, we believe that the loss of up to two Gulf of Maine DPS Atlantic salmon over a five-year period as a result of the proposed actions will not reduce the likelihood of survival and recovery of the Gulf of Maine DPS of Atlantic salmon.

9.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the proposed actions, and the cumulative effects, it is our biological opinion that the proposed actions may adversely affect but are not likely to jeopardize the continued existence of sperm whales; the NWA DPS of loggerhead sea turtles; Kemp's ridley sea turtles; the North Atlantic DPS of green sea turtles; leatherback sea turtles; shortnose sturgeon; the GOM, NYB, CB, Carolina, or SA DPSs of Atlantic sturgeon; or the Gulf of Maine DPS of Atlantic salmon.

10.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, non-migratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof" (16 U.S.C. 1532(8)). "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 NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA section 9 (51 FR 19936; June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person "to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA]." (16 U.S.C. 1538(g)). A "person" is defined in part as any entity subject to the jurisdiction of the U.S., including an individual, corporation, officer, employee, department, or instrument of the Federal government (see 16 U.S.C. 1532 (13)). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of carrying out an otherwise lawful activity is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this ITS. In issuing ITSs, NMFS takes no position on whether an action is an "otherwise lawful activity."

The measures described below are non-discretionary, and must be undertaken by NMFS so that they become binding conditions for the exemption in section 7(o)(2) to apply. NMFS has a continuing duty to regulate the activity covered by this ITS. If NMFS (1) fails to assume and implement the terms and conditions or (2) fails to require survey vessels to adhere to the terms and conditions of the ITS through enforceable terms that are added to permits and/or contracts as appropriate, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NMFS must report the progress of the action and its impact on the species to the NMFS as specified in the ITS [50 CFR §402.14(i)(3)] (See USFWS and NMFS's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

10.1 Anticipated Amount or Extent of Incidental Take

Based on the information presented in the Opinion, we anticipate that the fisheries and ecosystem research projects being conducted and funded by the NEFSC over the next five years (and in future five-year periods) will result in the capture of:

- up to 85 NWA DPS loggerhead sea turtles (ten lethal);
- up to 95 Kemp's ridley sea turtles (15 lethal);
- up to ten North Atlantic DPS green sea turtles (none lethal);
- up to ten leatherback sea turtles (five lethal);
- up to ten shortnose sturgeon (one lethal);
- up to 595 Atlantic sturgeon (30 lethal)
  - up to 308 from the NYB DPS (15 lethal),
  - up to 130 from the SA DPS (seven lethal),
  - up to 70 from the CB DPS (four lethal),
  - up to 60 from the GOM DPS (three lethal),
  - up to 14 from the Carolina DPS (one lethal),
  - up to 13 Canadian origin (non-listed);
- up to five Gulf of Maine DPS Atlantic salmon (two lethal).

Again, we have determined that this level of anticipated take is not likely to result in jeopardy to any species of sea turtle, shortnose sturgeon, or any DPS of Atlantic sturgeon or Atlantic salmon.

We have concluded that the NEFSC's fisheries and ecosystem research over a five-year period is likely to result in incidental take of sperm whales in the form of acoustic harassment. The exposure to underwater noise from the two primary acoustic sources (Simrad EK60 and Simrad ME70) is expected to cause behavioral effects, such as disruption of feeding, resting, or other activities or alterations in breathing, vocalizing, or diving rates. The project-related acoustic effects from these sources will be temporary, short term, and geographically limited to a very small portion of the overall species' range. The OPR's Permits and Conservation Division has proposed to issue a LOA for the harassment of a small number of marine mammals incidental to the proposed actions. The LOA is also proposed to be effective for a period of five years (80 FR 39542; July 9, 2015). The LOA proposed to authorize up to 15 incidents of take of sperm whales over the course of the five-year period. Each of these exposures will be considered a take by harassment. The amount of exempted take will be exceeded if any sperm whales are harmed, injured, or killed as a result of the proposed action, or if the number of such whale take occurrences by acoustic harassment as defined above exceeds the estimate of 15 events. For sperm whales, this ITS is only valid over the lifespan of the LOA, unless renewed in the future.

While the Opinion includes an estimate of the number of sperm whales that are likely to be harassed, this Opinion does not include an incidental take exemption for sperm whales at this time because the incidental take of these ESA-listed whales has not been authorized under section 101(a)(5) of the MMPA. Following the issuance of any such final authorizations, we may amend this Opinion to include an incidental take exemption and reasonable and prudent measures and terms and conditions for these species, as appropriate.

10.2 Reasonable and Prudent Measures

In order to effectively monitor the effects of the proposed actions, it is necessary to monitor the impacts of these actions to document the amount of incidental take (i.e., the number of sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon captured, injured, or killed) and to examine any sea turtles, sturgeon, or salmon that are captured during this monitoring. Monitoring provides information on the characteristics of sea turtles, sturgeon, and salmon encountered and may provide data which will help develop more effective measures to avoid future interactions with ESA-listed species. We do not anticipate any additional injury or mortality to be caused by handling and examining sea turtles, sturgeon, and salmon as required in the reasonable and prudent measures (RPMs) listed below. Unless staff have received the proper disentanglement training or are under the direct guidance of regional stranding or disentanglement experts, all live animals are to be released back into the water following the required documentation.

NMFS believes the following RPMs are necessary or appropriate to minimize and monitor the impacts of incidental take of sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon. They include a training requirement for NEFSC cruise and cooperative research staff (#1), which must be accomplished through workshops in the classroom or the field, followed by four sets of activities that must be conducted and completed by NEFSC cruise and cooperative research staff while at sea in the order listed below in the aftermath of any event of incidental take (#2-#5).

1. PROTECTED SPECIES OBSERVER AND DISENTANGLEMENT TRAINING: NEFSC staff scientists and/or crew regularly participating in research cruises or cooperative research studies that may interact with ESA-listed species must obtain or possess both protected species observer training (to be given through the NEFOP) and sea turtle disentanglement training (to be provided by staff from the GARFO PRD). This is an absolute requirement for staff scientists and crew involved in the following survey programs which have had past interactions with ESA-listed species: (1) COASTSPAN, (2) Spring and Fall NEFSC BTS, (3) Spring and Fall NEAMAP, and (4) Apex Predators.

2. HANDLING AND RESUSCITATION: Any sea turtles, shortnose sturgeon, Atlantic sturgeon, or Atlantic salmon caught and retrieved in gear used in NEFSC research cruises or cooperative research projects covered under this Opinion must be handled and resuscitated (if unresponsive) according to established protocols and whenever at-sea conditions are safe for those handling and resuscitating the animal(s) to do so.

3. DATA COLLECTION, SAMPLING, AND TAGGING: Any sea turtles, shortnose sturgeon, Atlantic sturgeon, or Atlantic salmon caught and/or retrieved in gear used in NEFSC research cruises or cooperative research projects covered under this Opinion must first be identified to species or species group. Each ESA-listed species caught

and/or retrieved must then be properly documented using appropriate equipment and data collection forms provided by the GARFO PRD, NEFSC, or NMFS Office of Science and Technology. Finally, biological data and samples must be collected for all sea turtles, sturgeon, and salmon caught and retrieved from fishing gear and appropriate tags be applied to the animals if it is determined that they have not been tagged already.

4. RELEASE OR RETENTION: Any live sea turtles, shortnose sturgeon, Atlantic sturgeon, or Atlantic salmon caught and retrieved in gear used in NEFSC research cruises or cooperative research projects covered under this Opinion must ultimately be released according to established protocols and whenever at-sea conditions are safe for those releasing the animal(s) to do so. Any dead sea turtles, shortnose sturgeon, Atlantic sturgeon, or Atlantic salmon must be retained, if logistically feasible and instructed by the GARFO PRD to do so, and then transferred to an appropriately permitted research facility either the GARFO PRD or NEFSC Protected Species Branch will identify so that a necropsy can be undertaken to attempt to determine the cause of death and/or other appropriate examinations can take place. Sea turtle, sturgeon, and salmon carcasses should be held in cold storage until shipping.

5. REPORTING: The GARFO PRD must be notified and/or a Protected Species Incidental Take (PSIT) database record must be entered for all observed takes of sea turtles, shortnose sturgeon, Atlantic sturgeon, or Atlantic salmon resulting from NEFSC research cruises or cooperative research projects covered under this Opinion.

10.3 Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, NMFS must comply with the following terms and conditions of the ITS, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this ITS shall not be considered a prohibited taking of the species concerned (ESA section 7(o)(2)).

1. To implement RPM #1 above, the NEFSC must ensure that for all fisheries and ecosystem research projects either with a history of sea turtle interactions or deploying fishing gear in areas and at times of year when sea turtles are present, staff scientists and/or crew members onboard possess NEFOP observer training and certification. At the very minimum, at least one staff scientist or crew member onboard must possess this training and be available to respond to an ESA-listed species interaction at all times (and preferably multiple members if a NOAA research vessel is the platform). To give NEFSC survey and cooperative research staff sufficient time to set up and obtain this training, we will allow a period of one year from the signature date of this Opinion for individuals not already trained to acquire the necessary training. However, due to past documented takes of ESA-listed species, at least one staff scientist or crew member onboard upcoming COASTSPAN, Spring and Fall NEFSC BTS, Spring and Fall NEAMAP, and Apex Predators surveys must already have this training.

2. To implement RPM #1 above, the NEFSC must ensure that for all fisheries and ecosystem research projects either with a history of sea turtle interactions or deploying fishing gear in areas and at times of year when sea turtles are present, staff scientists and/or crew members onboard possess sea turtle disentanglement training. At the very minimum, at least one staff scientist or crew member onboard must possess this training and be available to respond to a sea turtle entanglement at all times (and preferably multiple members if a NOAA research vessel is the platform). In addition, those vessels deploying fixed gear (e.g., gillnets, pots/traps) or line gear (e.g., longline, hook and line) or for which sea turtle interactions have occurred in the past must have adequate disentanglement equipment onboard. Survey and cooperative research staff with adequate disentanglement training are authorized through this Opinion to disentangle sea turtles according to the Northeast Atlantic Coast STDN Disentanglement Guidelines at http://www.greateratlantic.fisheries.noaa.gov/protected/stranding/disentanglements/turtle/stdn.html. The NEFSC should contact Kate Sampson (978-282-8470) or the GARFO PRD Sea Turtle Program (978-281-9328) for information on required disentanglement protocols and equipment and to set up any required training. All disentanglement must be done in accordance with NEFOP protocols or the procedures described in "Careful Release Protocols for Sea Turtle Release with Minimal Injury" (NOAA Technical Memorandum 580; http://www.sefsc.noaa.gov/turtles/TM_580_SEFSC_CRP_2008.pdf). To give NEFSC survey and cooperative research staff sufficient time to set up and obtain this training, we will allow a period of one year from the signature date of this Opinion for individuals not already trained to acquire the necessary training.

3. To implement RPM #2 above, the NEFSC must ensure that all NEFSC survey and cooperative research vessels and their staff onboard have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) and as reproduced in the wheelhouse card in Appendix C prior to the commencement of any on-water activity. The NEFSC or its research partners must carry out these handling and resuscitation procedures any time a sea turtle is incidentally captured and brought onboard the vessel during the proposed actions. It is requested that only NEFOP trained staff scientists or crew members onboard perform the handling and resuscitation of captured sea turtles.

4. To implement RPM #2 above, the NEFSC must ensure that survey and cooperative research staff give priority to the handling and resuscitation of any sea turtles, sturgeon, or salmon that are captured in the gear being used, if conditions at sea are safe to do so. Handling times for these species should be minimized (i.e., kept to 15 minutes or less) to limit the amount of stress placed on the animals.

5. To implement RPM #2 (as well as #4) above, for sea turtles encountered during fisheries and ecosystem research that appear injured, sick, distressed, or dead (including stranded or entangled individuals), NEFSC survey and cooperative research staff must immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-NOAA (6622) for further instructions and guidance on handling, retention, and/or disposal of the animal. If unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the USCG should be contacted via VHF marine radio on Channel 16. If required, hard-shelled sea turtles (i.e., non-leatherbacks)

may be held on board for up to 24 hours provided that conditions during holding are approved by the GARFO PRD and safe handling practices are followed. If the hotline or an available veterinarian cannot be contacted and the injured animal cannot be taken to a rehabilitation center, NEFSC affiliated researchers must cease activities that could further stress the animal, allow it to rest and recuperate as conditions dictate, and then return the animal to the sea.

6. To implement RPM #2 above, the NEFSC must ensure that survey and cooperative research staff attempt to resuscitate any shortnose sturgeon, Atlantic sturgeon, or Atlantic salmon that are unresponsive or comatose by providing a running source of water over the gills.

7. To comply with RPM #3 above, the NEFSC must ensure that both survey vessels and those vessels participating in cooperative research projects have at least one staff member onboard at all times that on-water work is being conducted who is experienced in the identification of sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon. This includes personnel that have received training and certification as a NMFS fisheries observer (NEFOP training is preferred) or who have career experience in the identification of these species. Although the NEFOP training manuals found at http://www.nefsc.noaa.gov/fsb/training/ are the best resource for species identification, we have also provided information in Appendix D to assist vessel staff and crew.

8. To implement RPM #3 (as well as #5) above, the NEFSC must ensure that both survey vessels and vessels participating in cooperative research projects with a history or likelihood of ESA-listed species take have a passive integrated transponder (PIT) tag reader onboard and that this reader be used to scan any captured sea turtles, sturgeon, or salmon for tags. Any recorded tags must be entered into the PSIT record or reported to the GARFO PRD. Any untagged sea turtles, sturgeon, or salmon must be tagged with PIT tags and the tag numbers recorded into the PSIT database or reported to the GARFO PRD. The NEFSC and GARFO PRD must work together to discuss how PIT tags and tag readers will be supplied to the required survey or cooperative research staff or vessels. To give NEFSC survey and cooperative research staff sufficient time to obtain the required PIT tagging equipment and training, we will allow a period of one year from the signature date of this Opinion for these discussions to occur and equipment to be procured, if they have not already.

9. To comply with RPM #3 above, the NEFSC must ensure that survey and cooperative research staff working on projects either with a history of sea turtle interactions or deploying fishing gear in areas and at times of year when sea turtles are present obtain two biopsy samples from all captured sea turtles (alive or dead). One sample must be collected for genetics and the other for stable isotope analysis. This must be done in accordance with NEFOP protocols. The recommended contents of a biopsy sampling kit and an instructional video for biopsy sampling can be found on the SEFSC's website at http://www.sefsc.noaa.gov/species/turtles/observers.htm. If the NEFSC or its research partners anticipate any difficulty in complying with the recommended procedures (due to materials availability, length of time away from port, etc.), they must contact the GARFO

PRD to discuss alternative sampling procedures prior to the start of any survey or cooperative research project that is expected to capture sea turtles. All biopsy samples for sea turtles should be sent to Heather Haas (Heather.Haas@noaa.gov), Research Fisheries Biologist of the NEFSC Protected Species Branch at 166 Water St, Woods Hole, MA 02543. To give NEFSC survey and cooperative research staff sufficient time to obtain the required biopsy sampling equipment and training, we will allow a period of one year from the signature date of this Opinion for these discussions to occur and equipment to be procured, if they have not already.

10. To comply with RPM #3 above, the NEFSC must ensure that survey and cooperative research staff either with a history of Atlantic sturgeon interactions or deploying fishing gear in areas and at times of year when Atlantic sturgeon are present obtain genetic samples from all captured Atlantic sturgeon (alive or dead). This must be done in accordance with the fin clip procedures provided by the GARFO PRD and as included in Appendix E. If the NEFSC or its research partners anticipate any difficulty in complying with the recommended procedures (due to materials availability, length of time away from port, etc.), they must contact the GARFO PRD to discuss alternative sampling or holding procedures prior to the start of any survey or cooperative research project that is expected to capture Atlantic sturgeon. To give NEFSC survey and cooperative research staff sufficient time to obtain the required biopsy sampling equipment and training, we will allow a period of one year from the signature date of this Opinion for these discussions to occur and equipment to be procured, if they have not already.

11. To comply with RPM #3 (as well as #5), the NEFSC must ensure that survey and cooperative research staff measure, weigh, and either photograph or video all sea turtles, sturgeon, and salmon incidentally captured. The condition of each animal and any potential injuries must be documented to the best of the staff member's ability. These data must be entered as part of the PSIT record for each incidental take.

12. To implement RPM #4, all live, uninjured sea turtles, sturgeon, and salmon that are incidentally captured during NEFSC surveys or cooperative research projects must be released back into the water as quickly as possible to minimize stress to the animal.

13. To implement RPM #4, in the event of any lethal takes of sea turtles, sturgeon, or salmon, any dead specimens or body parts must be preserved (frozen is preferred, although refrigerated is permitted as well if a freezer is not available) until retention or disposal procedures are discussed with the GARFO PRD. In the event a carcass is severely damaged or decayed to the point at which a necropsy would not be feasible, the animal should be disposed of at sea after a genetic sample is taken. It is up to the NEFOP-trained or experienced staff member onboard to assess the state of damage/decay and to ultimately make the call as to whether a necropsy is possible. The form included as Appendix H (sturgeon salvage form) must also be completed and submitted to us for any dead sturgeon captured.

14. To comply with RPM #5, the NEFSC or its research partners must ensure that either a PSIT record is entered (online at https://www.st.nmfs.noaa.gov/finss/psit/psitMain.jsp) or

the GARFO PRD is notified within 48 hours of any interaction with a sea turtle, sturgeon, or salmon. These reports, if unable to be entered into the PSIT database (see Appendix F for a data entry snapshot), can instead be sent via e-mail to Incidental.take@noaa.gov (preferred), sent by fax to (978) 281-9394, or called in to the GARFO PRD. The report must include at a minimum: (1) survey name and applicable information (e.g., vessel name, station number); (2) GPS coordinates describing the location of the interaction (in decimal degrees or degrees/minutes/seconds); (3) gear type involved (e.g., bottom trawl, gillnet, longline); (4) time and date of the interaction; and (5) identification of the animal to the species level. We also request that in the "Comments" field of the PSIT entry the following information be provided: (1) a link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes); (2) length/width and weight of the animal; (3) ID numbers of external or PIT tags either recorded or applied to the animal; (4) condition of the animal upon retrieval and release/retention (e.g., alive uninjured, alive potentially injured, comatose or unresponsive, fresh dead, decomposed); and (5) a description of any care or handling provided. If reporting within 48 hours is not possible (e.g., due to distance from shore or lack of ability to communicate via phone, fax, or email), the interaction must be reported as soon as the vessel is in a position to do so and absolutely no later than 48 hours after the vessel returns to port. If the PSIT database reporting form cannot be filled out and submitted to us, two alternate reporting formats (one developed previously by the NEFSC, the other developed by the GARFO PRD) have been included as Appendix G to this document.

15. To comply with RPM #5, the NEFSC Protected Species Branch must provide a tabular summary to the GARFO PRD within six months of completion of all on-water survey or cooperative research work for a given calendar year, providing a summary spreadsheet of ESA-listed species interactions that occurred by cruise/vessel/trip and species. Any reports required by Term and Condition #14 that have not been entered into the PSIT database or provided to the GARFO PRD must be included in this report. It is requested that this summary report be included as part of the annual "Omnibus data response" prepared each spring by the Protected Species Branch and sent to the GARFO PRD.

The RPMs, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed actions. Specifically, these RPMs and Terms and Conditions will ensure that NMFS (inclusive of the NEFSC and GARFO PRD) monitors the impacts of the subject research projects in a way that allows for the detection, identification, and reporting of all interactions with ESA-listed species. The discussion below explains why each of these RPMs and Terms and Conditions are necessary or appropriate to minimize or monitor the level of incidental take associated with the proposed actions. The RPMs and Terms and Conditions involve only a minor change (i.e., addition of effort and investigation) to the proposed actions.

RPM #1 and the accompanying Terms and Conditions establish the protected species training and certifications that NEFSC-affiliated survey vessel and cooperative research staff must obtain or possess prior to being employed on a project that may result in the incidental take of ESA-listed species. These types of training will provide staff scientists and vessel crew members with adequate experience in the handling, resuscitation, sampling, release, and reporting of sea turtles, sturgeon, and salmon that may be incidentally captured over the course of the proposed actions.

RPM #2 and the accompanying Terms and Conditions establish the requirements for handling and resuscitating sea turtles, sturgeon, and salmon captured in gear used in NEFSC conducted and funded fisheries and ecosystem research in order to avoid the likelihood of injury or mortality to these species from the hauling, handling, and emptying of fishing gear.

RPM #3 and the accompanying Terms and Conditions specify the collection of information for any sea turtles, sturgeon, or salmon observed captured in the gear. This is essential for monitoring the impacts of the proposed actions and level of incidental take associated with them. Sampling of sea turtle, sturgeon, and salmon tissue is used for genetic sampling. The taking of biopsy samples for sea turtles and fin clips for sturgeon and salmon allows NMFS to run genetic analysis to determine the nesting beach/DPS origin of sea turtles and the DPS origin of Atlantic sturgeon and Atlantic salmon. This allows us to determine if the actual level of take has been exceeded. These procedures do not harm sea turtles, sturgeon, or salmon and are a common practice in fisheries science. Tissue sampling does not appear to impair an animal's ability to swim and is not thought to have any long-term adverse impact. NMFS has received no reports of injury or mortality to any sea turtles, sturgeon, or salmon sampled in this way.

RPM #4 and the accompanying Terms and Conditions establish the requirements for releasing or retaining sea turtles, sturgeon, and salmon captured in gear used in NEFSC conducted and funded fisheries and ecosystem research in order to provide live animals with the best chance for survival post-capture and to gather additional information on the cause of death of dead animals.

RPM #5 and the accompanying Terms and Conditions specify protocols for the reporting of information to the GARFO PRD for any sea turtles, sturgeon, or salmon observed captured in the gear. This is essential for monitoring the level of incidental take associated with the proposed actions and ensuring that we can track any exceedance of the ITS.

11.0 CONSERVATION RECOMMENDATIONS

In addition to section 7(a)(2), which requires agencies to ensure that proposed actions are not likely to jeopardize the continued existence of listed species, section 7(a)(1) of the ESA places a responsibility on all Federal agencies to use their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered and threatened species. Conservation Recommendations are discretionary activities designed to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The following additional measures are recommended regarding incidental take and conservation of marine mammals, sea turtles, shortnose and Atlantic sturgeon, and Atlantic salmon:

1. NMFS should advise the Principal Investigator(s) for any projects conducted under this Opinion to provide guidance, before each survey cruise or fishing trip, to the vessel crew members (including scientific crew and vessel operators) to the effect that: (a) all personnel are alert to the possible presence of marine mammals, sea turtles, shortnose and

Atlantic sturgeon, and Atlantic salmon in the study area, (b) care must be taken when emptying gear to avoid damage to sea turtles, sturgeon, and salmon that may be caught in the gear but are not visible upon retrieval of the gear, and (c) the gear is emptied as quickly as possible after retrieval in order to determine whether sea turtles, sturgeon, or salmon are present in the gear.

12.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the fisheries and ecosystem research to be conducted and funded by the NEFSC over a five-year period and the proposed issuance of an LOA by NMFS OPR to permit marine mammal takes under those projects. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the agency actions are subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the actions. In the event that the amount or extent of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

13.0 LITERATURE CITED

Aguilar, A. 2002. Fin whale, *Balaenoptera physalus*. Pages 435-438 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

Andrews, H.V., and K. Shanker. 2002. A significant population of leatherback turtles in the Indian Ocean. Kachhapa 6:19.

Andrews, H.V., S. Krishnan, and P. Biswas. 2002. Leatherback nesting in the Andaman and Nicobar Islands. Kachhapa 6:15-18.

Antonelis, G.A., J.D. Baker, T.C. Johanos, R.C. Braun and A.L. Harting. 2006. Hawaiian monk seal (*Monachus schauinslandi*): status and conservation issues. Atoll Research Bulletin 543:75-101.

Armstrong, J.L., and J.E. Hightower. 2002. Potential for restoration of the Roanoke River population of Atlantic sturgeon. Journal of Applied Ichthyology 18:475-480.

ASMFC (Atlantic States Marine Fisheries Commission). 1998a. Atlantic Sturgeon Stock Assessment Peer Review Report. March 1998. 139 pp.

ASMFC (Atlantic States Marine Fisheries Commission). 1998b. Amendment 1 to the interstate fishery management plan for Atlantic sturgeon. Management Report No. 31. 43 pp.

ASMFC (Atlantic States Marine Fisheries Commission). 2002. Amendment 4 to the Interstate Fishery Management Plan for weakfish. Fishery Management Report No. 39. Washington, D.C.: Atlantic States Marine Fisheries Commission.

ASMFC (Atlantic States Marine Fisheries Commission). 2004. Horseshoe crab 2004 stock assessment. Washington, D.C.: Atlantic States Marine Fisheries Commission.

ASMFC (Atlantic States Marine Fisheries Commission). 2010. Atlantic Sturgeon. Pages 19-20 in Atlantic States Marine Fisheries Commission 2010 Annual Report. 68 pp.

ASMFC TC (Atlantic States Marine Fisheries Commission Technical Committee). 2007. Special Report to the Atlantic Sturgeon Management Board: Estimation of Atlantic sturgeon bycatch in coastal Atlantic commercial fisheries of New England and the Mid-Atlantic. August 2007. 95 pp.

ASSRT (Atlantic Sturgeon Status Review Team). 1998. Status review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). National Marine Fisheries Service. September 1998. 126 pp.

ASSRT (Atlantic Sturgeon Status Review Team). 2007. Status review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). National Marine Fisheries Service. February 23, 2007. 188 pp.

Attrill, M.J., J. Wright, and M. Edwards. 2007. Climate-related increases in jellyfish frequency suggest a more gelatinous future for the North Sea. Limnology and Oceanography 52:480-485.

Avens, L., J.C. Taylor, L.R. Goshe, T.T. Jones, and M. Hastings. 2009. Use of skeletochronological analysis to estimate the age of leatherback sea turtles *Dermochelys coriacea* in the western North Atlantic. Endangered Species Research 8:165-177.

Bain, M.B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M.B., N. Haley, D. Peterson, J. R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River Estuary: Lessons for Sturgeon Conservation. Instituto Espanol de Oceanografia Boletin 16:43-53.

Baker, J.D., C.L. Littnan, and D.W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 2:21-30.

Balazik, M.T., G.C. Garman, M.L. Fine, C.H. Hager, and S.P. McIninch. 2010. Changes in age composition and growth characteristics of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) over 400 years. Biology Letters Online, 17 March 2010. 3 pp.

Balazik, M.R., S.P. McInnich, G.C. Garman, and R.J. Latour. 2012. Age and growth of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the James River, Virginia, 1997-2011. Transactions of the American Fisheries Society 141(4):1074-1080.

Balazs, G.H. 1982. Growth rates of immature green turtles in the Hawaiian Archipelago. Pages 117-125 in K.A. Bjorndal, ed. Biology and conservation of sea turtles. Washington, D.C.: Smithsonian Institution Press.

Balazs, G.H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. Pages 387-429 in R.S. Shomura and O. Yoshida, eds. Proceedings of the Workshop on the Fate and Impact of Marine Debris, 27-29 November 1984, Honolulu, Hawaii. NOAA Technical Memorandum NMFS-SWFSC-54.

Bass, A.L., S.P. Epperly, and J. Braun-McNeill. 2004. Multiyear analysis of stock composition of a loggerhead turtle (*Caretta caretta*) foraging habitat using maximum likelihood and Bayesian methods. Conservation Genetics 5:783-796.

Berry, R.J. 1971. Conservation aspects of the genetical constitution of populations. Pages 177-206 in E.D. Duffey and A.S. Watt, eds. The Scientific Management of Animal and Plant Communities for Conservation. Blackwell, Oxford.

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin, U.S. Fish and Wildlife Service 74(53). 577 pp.

Bjorndal, K.A. 1985. Nutritional ecology of sea turtles. Copeia 1985(3):736-751.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. Pages 199-233 in P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. New York: CRC Press.

Blumenthal, J.M., J.L. Solomon, C.D. Bell, T.J. Austin, G. Ebanks-Petrie, M.S. Coyne, A.C. Broderick, and B.J. Godley. 2006. Satellite tracking highlights the need for international cooperation in marine turtle management. Endangered Species Research 2:51-61.

Bolten, A.B., K.A. Bjorndal, H.R. Martins, T. Dellinger, M.J. Biscoito, S.E. Encalada, and B.W. Bowen. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecological Applications 8(1):1-7.

Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. Environmental Biology of Fishes 48:399-405.

Borodin, N. 1925. Biological observations on the Atlantic sturgeon, *Acipenser sturio*. Transactions of the American Fisheries Society 55:184-190.

Bowen, B.W. 2003. What is a loggerhead turtle? The genetic perspective. Pages 7-27 in A.B. Bolten and B.E. Witherington, eds. Loggerhead Sea Turtles. Washington, D.C.: Smithsonian Press.

Bowen, B.W., and S.A. Karl. 2007. Population genetics and phylogeography of sea turtles. Molecular Ecology 16:4886-4907.

Bowen, B.W., A.L. Bass, S.-M. Chow, M. Bostrom, K.A. Bjorndal, A.B. Bolten, T. Okuyama, B.M. Bolker., S. Epperly, E. Lacasella, D. Shaver, M. Dodd, S.R. Hopkins-Murphy, J.A. Musick, M. Swingle, K. Rankin-Baransky, W. Teas, W.N. Witzell, and P.H. Dutton. 2004. Natal homing in juvenile loggerhead turtles (*Caretta caretta*). Molecular Ecology 13:3797-3808.

Bowen, B.W., A.L. Bass, L. Soares, and R.J. Toonen. 2005. Conservation implications of complex population structure: lessons from the loggerhead turtle (*Caretta caretta*). Molecular Ecology 14:2389-2402.

Braun, J., and S.P. Epperly. 1996. Aerial surveys for sea turtles in southern Georgia waters, June 1991. Gulf of Mexico Science 1996(1):39-44.

Braun-McNeill, J., and S.P. Epperly. 2004. Spatial and temporal distribution of sea turtles in the western North Atlantic and the U.S. Gulf of Mexico from Marine Recreational Fishery Statistics Survey (MRFSS). Marine Fisheries Review 64(4):50-56.

Braun-McNeill J., S.P. Epperly, L. Avens, M.L. Snover, and J.C. Taylor. 2008. Life stage duration and variation in growth rates of loggerhead (*Caretta caretta*) sea turtles from the western North Atlantic. Herpetological Conservation and Biology 3(2):273-281.

Brodeur, R.D., C.E. Mills, J.E. Overland, G.E. Walters, and J.D. Schumacher. 1999. Evidence for a substantial increase in gelatinous zooplankton in the Bering Sea, with possible links to climate change. Fisheries Oceanography 8(4):296-306.

Brown, J.J., and G.W. Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. Fisheries 35(2):72-83.

Brundage, H., and J. O'Herron. 2009. Investigations of juvenile shortnose and Atlantic sturgeons in the Delaware River. Bulletin of the New Jersey Academy of Science 52:1-8.

Burke, V.J., E.A. Standora, and S.J. Morreale. 1993. Diet of juvenile Kemp's ridley and loggerhead sea turtles from Long Island, New York. Copeia 1993(4):1176-1180.

Burke, V.J., S.J. Morreale, and E.A. Standora. 1994. Diet of the Kemp's ridley sea turtle, *Lepidochelys kempii*, in New York waters. Fishery Bulletin 92:26-32.

Bushnoe, T.M., J.A. Musick, and D.S. Ha. 2005. Essential spawning and nursery habitat of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in Virginia. VIMS Special Scientific Report 145. 44 pp.

Caillouet, C., C.T. Fontaine, S.A. Manzella-Tirpak, and T.D. Williams. 1995. Growth of head-started Kemp's ridley sea turtles (*Lepidochelys kempi*) following release. Chelonian Conservation and Biology 1(3):231-234.

Calvo, L., H.M. Brundage, D. Haivogel, D. Kreeger, R. Thomas, J.C. O'Herron, and E. Powell. 2010. Effects of flow dynamics, salinity, and water quality on the Eastern oyster, the Atlantic sturgeon, and the shortnose sturgeon in the oligohaline zone of the Delaware Estuary. Prepared for the U.S. Army Corps of Engineers, Philadelphia District. 108 pp.

Caron, F., D. Hatin, and R. Fortin. 2002. Biological characteristics of adult Atlantic sturgeon (*Acipenser oxyrinchus*) in the Saint Lawrence River estuary and the effectiveness of management rules. Journal of Applied Ichthyology 18:580-585.

Carr, A.R. 1963. Panspecific reproductive convergence in *Lepidochelys kempi*. Ergebnisse der Biologie 26:298-303.

Carreras, C., S. Pont, F. Maffucci, M. Pascual, A. Barceló, F. Bentivegna, L. Cardona, F. Alegre, M. SanFélix, G. Fernández, and A. Aguilar. 2006. Genetic structuring of immature loggerhead sea turtles (*Caretta caretta*) in the Mediterranean Sea reflects water circulation patterns. Marine Biology 149:1269-1279.

Casale, P., P. Nicolosi, D. Freggi, M. Turchetto, and R. Argano. 2003. Leatherback turtles (*Dermochelys coriacea*) in Italy and in the Mediterranean basin. Herpetological Journal 13:135-139.

Castroviejo, J., J.B. Juste, J.P. Del Val, R. Castelo, and R. Gil. 1994. Diversity and status of sea turtle species in the Gulf of Guinea islands. Biodiversity and Conservation 3:828-836.

CeTAP (Cetacean and Turtle Assessment Program). 1982. Final report or the cetacean and turtle assessment program, University of Rhode Island, to Bureau of Land Management, U.S. Department of the Interior. Ref. No. AA551-CT8-48. 568 pp.

Chevalier, J., X. Desbois, and M. Girondot. 1999. The reason for the decline of leatherback turtles *(Dermochelys coriacea*) in French Guiana: a hypothesis. Pages 79-88 in C. Miaud and R. Guyétant, eds. Current Studies in Herpetology, Proceedings of the ninth ordinary general meeting of the Societas Europea Herpetologica, 25-29 August 1998, Le Bourget du Lac, France.

Clapham. P. 2002. Humpback whale, *Megaptera novaeangliae*. Pages 589-592 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

Cliffton, K., D.O. Cornejo, and R.S. Felger. 1982. Sea turtles of the Pacific coast of Mexico. Pages 199-209 in K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Washington, D.C.: Smithsonian Institution Press.

Collins, M.R., and T.I.J. Smith. 1997. Distribution of shortnose and Atlantic sturgeons in South Carolina. North American Journal of Fisheries Management 17:995-1000.

Collins, M.R., S.G. Rogers, T.I.J. Smith, and M.L. Moser. 2000. Primary factors affecting sturgeon populations in the southeastern United States: fishing mortality and degradation of essential habitats. Bulletin of Marine Science 66:917-928.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. 222 pp.

Coyne, M.S. 2000. Population Sex Ratio of the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*): Problems in Population Modeling. PhD Thesis, Texas A&M University. 136 pp.

Coyne, M., and A.M. Landry, Jr. 2007. Population sex ratios and its impact on population models. Pages 191-211 in P.T. Plotkin, ed. Biology and Conservation of Ridley Sea Turtles. Baltimore: Johns Hopkins University Press.

Crance, J.H. 1987. Habitat suitability index curves for anadromous fishes. *In*: Common Strategies of Anadromous and Catadromous Fishes, M. J. Dadswell (ed.). Bethesda, Maryland, American Fisheries Society. Symposium 1:554.

Dadswell, M. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. Fisheries 31:218-229.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum*, LeSuer 1818. NOAA Technical Report NMFS 14, Washington, D.C.

Damon-Randall, K., M. Colligan, and J. Crocker. 2013. Composition of Atlantic sturgeon in rivers, estuaries, and in marine waters. White paper. NOAA/NMFS, Gloucester, Massachusetts: Protected Resources Division.

Daniels, R.C., T.W. White, and K.K. Chapman. 1993. Sea-level rise: destruction of threatened and endangered species habitat in South Carolina. Environmental Management 17(3):373-385.

Davenport, J. 1997. Temperature and the life-history strategies of sea turtles. Journal of Thermal Biology 22(6):479-488.

Davenport, J., and G.H. Balazs. 1991. 'Fiery bodies' – Are pyrosomas an important component of the diet of leatherback turtles? British Herpetological Society Bulletin 37:33-38.

Dees, L.T. 1961. Sturgeons. U.S. Fish and Wildlife Service Fishery Leaflet 526. 8 pp.

DFO (Division of Fisheries and Oceans). 2011. Atlantic Sturgeon and Shortnose Sturgeon Maritimes Region Summary Report. U.S. Sturgeon Workshop. Alexandria, Virginia, 8-10 February 2011. 11 pp.

Dodd, C.K. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service Biological Report 88(14):1-110.

Doughty, R.W. 1984. Sea turtles in Texas: a forgotten commerce. Southwestern Historical Quarterly 88:43-70.

Dovel, W.L., and T.J. Berggren. 1983. Atlantic sturgeon of the Hudson River Estuary, New York. New York Fish and Game Journal 30: 140-172.

Duarte, C.M. 2002. The future of seagrass meadows. Environmental Conservation 29:192-206.

Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.J. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. Fishery Bulletin 108:450-465.

Dutton, P.H., C. Hitipeuw, M. Zein, S.R. Benson, G. Petro, J. Pita, V. Rei, L. Ambio, and J. Bakarbessy. 2007. Status and genetic structure of nesting populations of leatherback turtles (*Dermochelys coriacea*) in the Western Pacific. Chelonian Conservation and Biology 6(1):47-53.

Dwyer, K.L., C.E. Ryder, and R. Prescott. 2002. Anthropogenic mortality of leatherback sea turtles in Massachusetts waters. Poster presentation for the 2002 Northeast Stranding Network Symposium.

Dwyer, K.L., C.E. Ryder, and R. Prescott. 2003. Anthropogenic mortality of leatherback sea turtles in Massachusetts waters. Page 260 in J.A. Seminoff, compiler. Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Eckert, S.A. 1999. Global distribution of juvenile leatherback turtles. Hubbs-Sea World Research Institute Technical Report 99-294:1-13.

Eckert, S.A., and J. Lien. 1999. Recommendations for eliminating incidental capture and mortality of leatherback sea turtles, *Dermochelys coriacea*, by commercial fisheries in Trinidad and Tobago. A report to the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). Hubbs-Sea World Research Institute Technical Report 2000-310:1-7.

Eckert, S.A., D. Bagley, S. Kubis, L. Ehrhart, C. Johnson, K. Stewart, and D. DeFreese. 2006. Internesting and postnesting movements of foraging habitats of leatherback sea turtles (*Dermochelys coriacea*) nesting in Florida. Chelonian Conservation and Biology 5(2):239-248.

Ehrhart, L.M., D.A. Bagley, and W.E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance, and population status. Pages 157-174 in A.B. Bolten and B.E. Witherington, eds. Loggerhead Sea Turtles. Washington, D.C.: Smithsonian Institution Press.

Ehrhart. L.M., W.E. Redfoot, and D.A. Bagley. 2007. Marine turtles of the central region of the Indian River Lagoon System, Florida. Florida Scientist 70(4):415-434.

EPA (Environmental Protection Agency). 2008. National Coastal Condition Report III. Office of Research and Development/Office of Water. Washington, D.C. 298 pp.

EPA CBP (Environmental Protection Agency Chesapeake Bay Program). 2010. 2010 State of the Chesapeake Bay Program. Summary Report to the Chesapeake Executive Council, June 3, 2010. 7 pp.

Epperly, S.P. 2003. Fisheries-related mortality and turtle excluder devices. Pages 339-353 in P.L. Lutz, J.A. Musick, and J. Wyneken, eds. The Biology of Sea Turtles, Volume 2. Boca Raton: CRC Press.

Epperly, S.P., and W.G. Teas. 2002. Turtle Excluder Devices - Are the escape openings large enough? Fishery Bulletin 100:466-474.

Epperly, S.P., J. Braun, and A.J. Chester. 1995a. Aerial surveys for sea turtles in North Carolina inshore waters. Fishery Bulletin 93:254-261.

Epperly, S.P., J. Braun, A.J. Chester, F.A. Cross, J.V. Merriner, and P.A. Tester. 1995b. Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bulletin of Marine Science 56(2):547-568.

Epperly, S.P., J. Braun, and A. Veishlow. 1995c. Sea turtles in North Carolina waters. Conservation Biology 9(2):384-394.

Epperly, S., L. Avens, L. Garrison, T. Henwood, W. Hoggard, J. Mitchell, J. Nance, J. Poffenberger, C. Sasso, E. Scott-Denton, and C. Yeung. 2002. Analysis of sea turtle bycatch in the commercial shrimp fisheries of southeast U.S. waters and the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-490:1-88.

Epperly, S.P., J. Braun-McNeill, and P.M. Richards. 2007. Trends in catch rates of sea turtles in North Carolina, USA. Endangered Species Research 3:283-293.

Erickson, D.L., A. Kahnle, M.J. Millard, E.A Mora, M. Bryja, A. Higgs, J. Mohler, M. DuFour, G. Kenney, J. Sweka, and E.K. Pikitch. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus* Mitchell, 1815. Journal of Applied Ichthyology 27:356-365.

Ernst, C.H., and R.W. Barbour. 1972. Turtles of the United States. Lexington: University Press of Kentucky.

Eyler, S., M. Mangold, and S. Minkkinen. 2004. Atlantic coast sturgeon tagging database. Summary Report prepared by U.S. Fish and Wildlife Service, Maryland Fishery Resource Office, Annapolis, Maryland. 51 pp.

Eyler, S., T. Meyer, S. Michaels, and B. Spear. 2007. Review of the fishery management plan in 2006 for horseshoe crab (*Limulus polyphemus*). Prepared by the ASMFC Horseshoe Crab Plan Review Team. 15pp.

Fenster, M., and D. FitzGerald. 1996. Morphodynamics, stratigraphy, and sediment transport patterns of the Kennebec River estuary, Maine. Sedimentary Geology 107:99-120.

Ferreira, M.B., M. Garcia, and A. Al-Kiyumi. 2003. Human and natural threats to the green turtles, *Chelonia mydas*, at Ra's al Hadd turtle reserve, Arabian Sea, Sultanate of Oman. Page 142 in J.A. Seminoff, compiler. Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Finkbeiner, E.M., B.P. Wallace, J.E. Moore, R.L. Lewison, L.B. Crowder, and A.J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation 144(11): 2719-2727.

Fish, M.R., I.M. Cote, J.A. Gill, A.P. Jones, S. Renshoff, and A.R.Watkinson. 2005. Predicting the impact of sea-level rise on Caribbean sea turtle nesting habitat. Conservation Biology 19:482-491.

Fisher, M. 2009. Atlantic Sturgeon Progress Report. State Wildlife Grant Project T-4-1. Delaware Division of Fish and Wildlife Department of Natural Resources and Environmental Control. Smyrna, Delaware. 24 pp.

Fisher, M. 2011. Atlantic Sturgeon Final Report. State Wildlife Grant Project T-4-1. Delaware Division of Fish and Wildlife Department of Natural Resources and Environmental Control. Smyrna, Delaware. 44 pp.

Fox, D.A., and M.W. Breece. 2010. Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the New York Bight DPS: Identification of critical habitat and rates of interbasin exchange. Final Report NOAA-NMFS Anadromous Fish Conservation Act Program. NOAA Award NA08NMF4050611. 64 pp.

Fox, D.A., K. Wark, J.L. Armstrong, and L.M. Brown. 2011. Gillnet configurations and their impact on Atlantic sturgeon and marine mammal bycatch in the New Jersey monkfish fishery: year 1. Final report. NMFS Contract No. EA133F-10-RQ-1160. 30 pp.

Fox, D.A., J.L. Armstrong, L.M. Brown, and K. Wark. 2012. The influence of sink gillnet profile on bycatch of Atlantic sturgeon in the Mid-Atlantic monkfish fishery. Completion report. NMFS Contract No. EA133F-10-SE-3358. 31 pp.

FPL (Florida Power and Light Company) and Quantum Resources. 2005. Florida Power and Light Company, St. Lucie Plant Annual Environmental Operating Report, 2002. 57 pp.

Frazer, N.B., and L.M. Ehrhart. 1985. Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. Copeia 1985(1):73-79.

Fritts, T.H. 1982. Plastic bags in the intestinal tracts of leatherback marine turtles. Herpetological Review 13(3):72-73.

Garrison, L.P., L. Stokes, and C. Fairfield. 2009. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2008. NOAA Technical Memorandum NMFS-SEFSC-591:1-58.

Garrison, L.P., and L. Stokes. 2014. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2013. NOAA Technical Memorandum NMFS-SEFSC-667:1-61.

George, R.H. 1997. Health Problems and Diseases of Sea Turtles. Pages 363-386 in P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. Boca Raton, Florida: CRC Press.

Gilbert, C.R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82, 28 pp.

Girondot, M., M.H. Godfrey, L. Ponge, and P. Rivalan. 2007. Modeling approaches to quantify leatherback nesting trends in French Guiana and Suriname. Chelonian Conservation and Biology 6(1):37-46.

Glen, F., and N. Mrosovsky. 2004. Antigua revisited: the impact of climate change on sand and nest temperatures at a hawksbill turtle (*Eretmochelys imbricata*) nesting beach. Global Change Biology 10:2036-2045.

GMFMC (Gulf of Mexico Fishery Management Council). 2007. Amendment 27 to the Reef Fish FMP and Amendment 14 to the Shrimp FMP to end overfishing and rebuild the red snapper stock. Tampa, Florida: Gulf of Mexico Fishery Management Council. 490 pp. with appendices.

Goff, G.P., and J.Lien. 1988. Atlantic leatherback turtle, *Dermochelys coriacea*, in cold water off Newfoundland and Labrador. Canadian Field Naturalist 102(1):1-5.

Graff, D. 1995. Nesting and hunting survey of the turtles of the island of Sao Tomé. Progress Report July 1995, ECOFAC Componente de Sao Tomé e Príncipe, 33 pp.

Greene, C.H., A.J. Pershing, T.M. Cronin, and N. Ceci. 2008. Arctic climate change and its impacts on the ecology of the North Atlantic. Ecology 89(11) Supplement 2008:S24-S38.

Greene, K.E., J.L. Zimmerman, R.W. Laney, and J.C. Thomas-Blate. 2009. Atlantic Coast Diadromous Fish Habitat: A Review of Utilization, Threats, Recommendations for Conservation, and Research Needs. Habitat Management Series No. 9. Washington, D.C.: Atlantic States Marine Fisheries Commission.

Grunwald, C., L. Maceda, J. Waldman, J. Stabile, and I. Wirgin. 2008. Conservation of Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*: delineation of stock structure and distinct population segments. Conservation Genetics 9:1111-1124.

Guilbard, F., J. Munro, P. Dumont, D. Hatin, and R. Fortin. 2007. Feeding ecology of Atlantic sturgeon and lake sturgeon co-occurring in the St. Lawrence Estuarine Transition Zone. American Fisheries Society Symposium 56:85-104.

Haley, N.J. 1999. Habitat characteristics and resource use patterns of sympatric sturgeons in the Hudson River estuary. Master's thesis. University of Massachusetts, Amherst.

Hatin, D., R. Fortin, and F. Caron. 2002. Movements and aggregation areas of adult Atlantic sturgeon (*Acipenser oxyrinchus*) in the Saint Lawrence River estuary, Quebec, Canada. Journal of Applied Ichthyology 18:586-594.

Hatin, D., J. Munro, F. Caron, and R.D. Simons. 2007. Movements, home range size, and habitat use and selection of early juvenile Atlantic sturgeon in the St. Lawrence estuarine transition zone. Pages 129-155 in J. Munro, D. Hatin, J.E. Hightower, K. McKown, K.L. Sulak, A.W. Kahnle, and F. Caron, eds. Anadromous sturgeon: habitat, threats, and management. American Fisheries Society Symposium 56. Bethesda, Maryland. 215 pp.

Hawkes, L.A., A.C. Broderick, M.H.Godfrey, and B.J. Godley. 2005. Status of nesting loggerhead turtles *Caretta caretta* at Bald Head Island (North Carolina, USA) after 24 years of intensive monitoring and conservation. Oryx 39(1):65-72.

Hawkes, L.A., A.C. Broderick, M.S. Coyne, M.H. Godfrey, L.-F. Lopez-Jurado, P. Lopez-Suárez, S.E. Merino, N. Varo-Cruz, and B.J. Godley. 2006. Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. Current Biology 16:990-995.

Hawkes, L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2007. Investigating the potential impacts of climate change on a marine turtle population. Global Change Biology 13:1-10.

Hawkes, L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2009. Climate change and marine turtles. Endangered Species Research 7:137-154.

Hays, G.C., A.C. Broderick, F. Glen, and B.J. Godley. 2003. Global climate change and sea turtles: a 150-year reconstruction of incubation temperatures at a major marine turtle rookery. Global Change Biology 9:642-646.

Henwood, T.A., and W. Stuntz. 1987. Analysis of sea turtle captures and mortalities during commercial shrimp trawling. Fishery Bulletin 85(4):813-817.

Heppell, S.S., D.T. Crouse, L.B. Crowder, S.P. Epperly, W. Gabriel, T. Henwood, R. Márquez, and N.B. Thompson. 2005. A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. Chelonian Conservation and Biology 4(4):767-773.

Hildebrand, S.F., and W.C. Schroeder. 1928. Fishes of the Chesapeake Bay. Washington, D.C.: Smithsonian Institute Press.

Hilterman, M.L., and E. Goverse. 2004. Annual report of the 2003 leatherback turtle research and monitoring project in Suriname. World Wildlife Fund - Guianas Forests and Environmental Conservation Project (WWF-GFECP) Technical Report of the Netherlands Committee for IUCN (NC-IUCN), Amsterdam, the Netherlands. 21 pp.

Hirth, H.F. 1971. Synopsis of biological data on the green sea turtle, Chelonia mydas. FAO Fisheries Synopsis 85:1-77.

Hirth, H.F. 1997. Synopsis of the biological data of the green turtle, *Chelonia mydas* (Linnaeus 1758). USFWS Biological Report 97(1):1-120.

Holland, B.F., Jr. and G.F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources, Division of Commercial and Sports Fisheries, Morehead City. Special Scientific Report 24:1-132.

Holton, J.W., Jr., and J.B. Walsh. 1995. Long-Term Dredged Material Management Plan for the Upper James River, Virginia. Virginia Beach, Waterway Surveys and Engineering, Limited. 94 pp.

Horwood, J. 2002. Sei whale, *Balaenoptera borealis*. Pages 1069-1071 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

Hulin, V., and J.M. Guillon. 2007. Female philopatry in a heterogeneous environment: ordinary conditions leading to extraordinary ESS sex ratios. BMC Evolutionary Biology 7:13.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43:617-627.

ICES (International Council for the Exploration of the Sea). 2005. Study Group on the Bycatch of Salmon in Pelagic Trawl Fisheries (SGBYSAL). ICES CM 2005 (ACFM:13), 41 pp.

Innis, C., C. Merigo, K. Dodge, M. Tlusty, M. Dodge, B. Sharp, A. Myers, A. McIntosh, D. Wunn, C. Perkins, T.H. Herdt, T. Norton, and M. Lutcavage. 2010. Health Evaluation of Leatherback Turtles (*Dermochelys coriacea*) in the Northwestern Atlantic During Direct Capture and Fisheries Gear Disentanglement. Chelonian Conservation and Biology, 9(2):205-222.

IPCC (Intergovernmental Panel on Climate Change). 2007a. Fourth Assessment Report. Valencia, Spain.

IPCC (Intergovernmental Panel on Climate Change). 2007b. Summary for Policymakers. *In* Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (editors). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

James, M.C., C.A. Ottensmeyer, and R.A. Myers. 2005a. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: new directions for conservation. Ecology Letters 8:195-201.

James, M.C., R.A. Myers, and C.A. Ottenmeyer. 2005b. Behaviour of leatherback sea turtles, *Dermochelys coriacea*, during the migratory cycle. Proceedings of the Royal Society of London B 272:1547-1555.

Johnson, J.H., D.S. Dropkin, B.E. Warkentine, J.W. Rachlin, and W.D. Andres. 1997. Food habits of Atlantic sturgeon off the New Jersey coast. Transactions of the American Fisheries Society 126:166-170.

Kahnle, A.W., K.A. Hattala, K.A. McKown, C.A. Shirey, M.R. Collins, T.S. Squiers, Jr., and T. Savoy. 1998. Stock Status of Atlantic sturgeon of Atlantic Coast Estuaries. Report for the Atlantic States Marine Fisheries Commission. Draft III.

Kahnle, A.W., K.A. Hattala, and K.A. McKown. 2007. Status of Atlantic sturgeon of the Hudson River Estuary, New York, USA. American Fisheries Society Symposium 56:347-363.

Kamel, S.J., and N. Mrosovsky. 2004. Nest-site selection in leatherbacks (*Dermochelys coriacea*): individual patterns and their consequences. Animal Behaviour 68:357-366.

Kasparek, M., B.J. Godley, and A.C. Broderick. 2001. Nesting of the green turtle, *Chelonia mydas*, in the Mediterranean: a review of status and conservation needs. Zoology in the Middle East 24:45-74.

Keinath, J.A., J.A. Musick, and R.A. Byles. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. Virginia Journal of Science 38(4):329-336.

Kenney, R.D. 2002. North Atlantic, North Pacific and Southern Right Whales. Pages 806-813 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

Kieffer, M., and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 122:1088-1103.

Kuller, Z. 1999. Current status and conservation of marine turtles on the Mediterranean coast of Israel. Marine Turtle Newsletter 86:3-5.

Kynard, B., and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, and shortnose sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63:137-150.

Kynard, B., M. Horgan, M. Kieffer, and D. Seibel. 2000. Habitats used by shortnose sturgeon in two Massachusetts rivers. Transactions of the American Fisheries Society 129:487-503.

LaCasella, E.L., P.H. Dutton, and S.P. Epperly. 2005. Genetic stock composition of loggerheads (*Caretta caretta*) encountered in the Atlantic northeast distant (NED) longline fishery using additional mtDNA analysis. Pages 302-303 in Frick M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Lacroix, G.L., and D. Knox. 2005. Distribution of Atlantic salmon (*Salmo salar*) postsmolts of different origins in the Bay of Fundy and Gulf of Maine and evaluation of factors affecting migration, growth, and survival. Canadian Journal of Fisheries and Aquatic Sciences 62:1363-1376.

Lagueux, C.J. 1998. Demography of marine turtles harvested by Miskitu Indians of Atlantic Nicaragua. Page 90 in R. Byles and Y. Fernandez, compilers. Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Laney, R.W., J.E. Hightower, B.R. Versak, M.F. Mangold, W.W. Cole Jr., and S.E. Winslow. 2007. Distribution, habitat use, and size of Atlantic sturgeon captured during cooperative winter tagging cruises, 1988-2006. Pages 167-182 in J. Munro, D. Hatin, J.E. Hightower, K. McKown, K.J. Sulak, A.W. Kahnle, and F. Caron, eds. Anadromous sturgeons: habitats, threats, and management. American Fisheries Society Symposium 56. Bethesda, Maryland. 215 pp.

Laurent, L., J. Lescure, L. Excoffier, B. Bowen, M. Domingo, M. Hadjichristophorou, L. Kornaraki, and G. Trabuchet. 1993. Genetic studies of relationships between Mediterranean and Atlantic populations of loggerhead turtle *Caretta caretta* with a mitochondrial marker. Comptes Rendus de l'Academie des Sciences (Paris), Sciences de la Vie/Life Sciences 316:1233-1239.

Laurent, L., P. Casale, M.N. Bradai, B.J. Godley, G. Gerosa, A.C. Broderick, W. Schroth, B. Schierwater, A.M. Levy, D. Freggi, E.M. Abd El-Mawla, D.A. Hadoud, H.E. Gomati, M. Domingo, M. Hadjichristophorou, L. Kornaraki, F. Demirayak, and C. Gautier. 1998. Molecular resolution of the marine turtle stock composition in fishery bycatch: a case study in the Mediterranean. Molecular Ecology 7:1529-1542.

Leland, J.G., III. 1968. A survey of the sturgeon fishery of South Carolina. Bears Bluff Labs. No. 47, 27 pp.

Lewison, R.L., L.B. Crowder, and D.J. Shaver. 2003. The impact of turtle excluder devices and fisheries closures on loggerhead and Kemp's ridley strandings in the western Gulf of Mexico. Conservation Biology 17(4):1089-1097.

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters 7:221-231.

Lichter, J., H. Caron, T.S. Pasakarnis, S.L. Rodgers, T.S. Squiers Jr., and C.S. Todd. 2006. The ecological collapse and partial recovery of a freshwater tidal ecosystem. Northeastern Naturalist 13:153-178.

Lutcavage, M.E., and P.L. Lutz. 1997. Diving physiology. Pages 277-296 in P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. Boca Raton, Florida: CRC Press.

Lutcavage, M., and J.A. Musick. 1985. Aspects of the biology of sea turtles in Virginia. Copeia 1985(2):449-456.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival. Pages 387-409 in P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. Boca Raton, Florida: CRC Press.

Maier, P.P., A.L. Segars, M.D. Arendt, J.D. Whitaker, B.W. Stender, L. Parker, R. Vendetti, D.W. Owens, J. Quattro, and S.R. Murphy. 2004. Development of an index of sea turtle abundance based on in-water sampling with trawl gear. Final report to the National Marine Fisheries Service. 86 pp.

Maier, P.P., A.L. Segars, M.D. Arendt, and J.D. Whitaker. 2005. Examination of local movement and migratory behavior of sea turtles during spring and summer along the Atlantic coast off the southeastern United States. Annual report for grant number NA03NMF4720281. 29pp.

Mangin, E. 1964. Croissance en Longueur de Trois Esturgeons d'Amerique du Nord: *Acipenser oxyrhynchus,* Mitchill, *Acipenser fulvescens*, Rafinesque, et *Acipenser brevirostris* LeSueur. Verh. Int. Ver. Limnology 15:968-974.

Mansfield, K. L. 2006. Sources of mortality, movements, and behavior of sea turtles in Virginia. Ph.D. dissertation, College of William and Mary. 343 pp.

Mansfield, K.L., J.A. Musick, and R.A. Pemberton. 2001. Characterization of the Chesapeake Bay pound net and whelk pot fisheries and their potential interactions with marine sea turtle species. Final Report to the National Marine Fisheries Service under Contract No. 43EANFO30131. 75 pp.

Mansfield, K.L., V.S. Saba, J. Keinath, and J.A. Musick. 2009. Satellite telemetry reveals a dichotomy in migration strategies among juvenile loggerhead sea turtles in the northwest Atlantic. Marine Biology 156:2555-2570.

Marcano, L.A., and J.J. Alio-M. 2000. Incidental capture of sea turtles by the industrial shrimping fleet off northwestern Venezuela. Page 107 in F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millán, and L. Sarti-Martínez, compilers. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436.

Márquez, R., A. Villanueva, and M. Sanchez. 1982. The population of Kemp's ridley sea turtle in the Gulf of Mexico, *Lepidochelys kempii*. Pages 159-164 in K. Bjorndal, ed. Biology and conservation of sea turtles. Washington, D.C.: Smithsonian Institution Press.

McClellan, C.M., and A.J. Read. 2007. Complexity and variation in loggerhead sea turtle life history. Biology Letters 3:592-594.

McCord, J.W., M.R. Collins, W.C. Post, and T.I.J. Smith. 2007. Attempts to Develop an Index of Abundance for Age-1 Atlantic Sturgeon in South Carolina, USA. American Fisheries Society Symposium 56:397-403.

McMahon, C.R., and G.C. Hays. 2006. Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Global Change Biology 12:1330-1338.

Meylan, A. 1982. Estimation of population size in sea turtles. Pages 135-138 in K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Washington, D.C.: Smithsonian Institute Press.

Meylan, A., B. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the state of Florida. Florida Marine Research Publication 52:1-51.

Mitchell, G.H., R.D. Kenney, A.M. Farak, and R.J. Campbell. 2003. Evaluation of occurrence of endangered and threatened marine species in naval ship trial areas and transit lanes in the Gulf of Maine and offshore of Georges Bank. NUWC-NPT Technical Memo 02-121A. March 2003. 113 pp.

MNRPD (Maine Natural Resources Policy Division). 1993. Kennebec River Resource Management Plan: Balancing Hydropower Generation and Other Uses. Augusta, Maine. 196 pp.

Mohler, J.W. 2003. Culture manual for the Atlantic sturgeon. U.S. Fish and Wildlife Service. Hadley, Massachusetts. 70 pp.

Monzón-Argüello, C., A. Marco., C. Rico, C. Carreras, P. Calabuig, and L.F. López-Jurado. 2006. Transatlantic migration of juvenile loggerhead turtles (*Caretta caretta*): magnetic latitudinal influence. Page 106 in M. Frick, A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Moore, S., and J. Reblin. 2010. The Kennebec Estuary: Restoration Challenges and Opportunities. Biological Conservation, Bowdoinham, Maine.

Morreale, S.J., and E.A. Standora. 1993. Occurrence, movement, and behavior of the Kemp's ridley and other sea turtles in New York waters. Okeanos Ocean Research Foundation Final Report April 1988-March 1993. 70 pp.

Morreale, S.J., and E.A. Standora. 1998. Early life stage ecology of sea turtles in northeastern U.S. waters. NOAA Technical Memorandum NMFS-SEFSC-413:1-49.

Morreale, S.J., and E.A. Standora. 2005. Western North Atlantic waters: crucial developmental habitat for Kemp's ridley and loggerhead sea turtles. Chelonian Conservation and Biology 4(4):872-882.

Morreale, S.J., C.F. Smith, K. Durham, R.A. DiGiovanni, Jr., and A.A. Aguirre. 2005. Assessing health, status, and trends in northeastern sea turtle populations. Interim report - Sept. 2002 - Nov. 2004. Gloucester, Massachusetts: National Marine Fisheries Service.

Mortimer, J.A. 1982. Feeding ecology of sea turtles. Pages 103-109 in K.A. Bjorndal, ed. Biology and conservation of sea turtles. Washington, D.C.: Smithsonian Institution Press.

Mrosovsky, N. 1981. Plastic jellyfish. Marine Turtle Newsletter 17:5-6.

Mrosovsky, N., P.H. Dutton, and C.P. Whitmore. 1984. Sex ratios of two species of sea turtle nesting in Suriname. Canadian Journal of Zoology 62:2227-2239.

Mrosovsky, N., G.D. Ryan, and M.C. James. 2009. Leatherback turtles: the menace of plastic. Marine Pollution Bulletin 58:287-289.

Munro, J, R.E. Edwards, and A.W. Kahnle. 2007. Summary and synthesis. Pages 1-15 in J. Munro, D. Hatin, J.E. Hightower, K. McKown, K.J. Sulak, A.W. Kahnle, and F. Caron, eds. Anadromous sturgeons: habitats, threats, and management. American Fisheries Society Symposium 56. Bethesda, Maryland.

Murawski, S.A., and A.L. Pacheco. 1977. Biological and fisheries data on Atlantic sturgeon, *Acipenser oxyrhynchus* (Mitchill). National Marine Fisheries Service Technical Series Report 10:1-69.

Murdoch, P.S., J.S. Baron, and T.L. Miller. 2000. Potential effects of climate change on surface-water quality in North America. Journal of the American Water Resources Association 36:347-366.

Murphy, T.M., and S.R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. Final Report to the National Marine Fisheries Service. 73pp.

Murphy, T.M., S.R. Murphy, D.B. Griffin, and C. P. Hope. 2006. Recent occurrence, spatial distribution and temporal variability of leatherback turtles (*Dermochelys coriacea*) in nearshore waters of South Carolina, USA. Chelonian Conservation and Biology 5(2):216-224.

Murray, K.T. 2004. Bycatch of sea turtles in the Mid-Atlantic sea scallop (*Placopecten magellanicus*) dredge fishery during 2003. NEFSC Reference Document 04-11; 25 pp.

Murray, K.T. 2006. Estimated average annual bycatch of loggerhead sea turtles (*Caretta caretta*) in U.S. Mid-Atlantic bottom otter trawl gear, 1996-2004. NEFSC Reference Document 06-19:1-26.

Murray, K.T. 2007. Estimated bycatch of loggerhead sea turtles (*Caretta caretta*) in U.S. Mid-Atlantic scallop trawl gear, 2004-2005, and in sea scallop dredge gear, 2005. NEFSC Reference Document 07-04; 30 pp.

Murray, K.T. 2008. Estimated average annual bycatch of loggerhead sea turtles (*Caretta caretta*) in U.S. Mid-Atlantic bottom otter trawl gear, 1996-2004 (2nd edition). NEFSC Reference Document 08-20; 32 pp.

Murray, K.T. 2009a. Proration of estimated bycatch of loggerhead sea turtles in U.S. Mid-Atlantic sink gillnet gear to vessel trip report landed catch, 2002-2006. NEFSC Reference Document 09-19; 7 pp.

Murray, K.T. 2009b. Characteristics and magnitude of sea turtle bycatch in US mid-Atlantic gillnet gear. Endangered Species Research 8:211-224.

Murray, K.T. 2011. Sea turtle bycatch in the U.S. sea scallop (*Placopecten magellanicus*) dredge fishery, 2001-2008. Fisheries Research 107:137-146.

Musick, J.A., and C.J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. Pages 137-164 in P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. Boca Raton, Florida: CRC Press.

Musick, J.A., R.E. Jenkins, and N.B. Burkhead. 1994. Sturgeons, family Acipenseridae. Pages 183-190 in R.E. Jenkins and N.B. Burkhead, eds. Freshwater Fishes of Virginia. Bethesda, Maryland: American Fisheries Society.

NAST (National Assessment Synthesis Team). 2000. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000. http://www.usgcrp.gov/usgcrp/Library/ nationalassessment/1IntroA.pdf.

NEFSC (Northeast Fisheries Science Center). 2011a. Preliminary summer 2010 regional abundance estimate of loggerhead turtles (*Caretta caretta*) in northwestern Atlantic Ocean continental shelf waters. NEFSC Reference Document 11-03; 33 pp.

NEFSC (Northeast Fisheries Science Center). 2011b. Summary of discard estimates for Atlantic sturgeon. Report prepared by Tim Miller and Gary Shepard, NEFSC Population Dynamics Branch, NMFS Northeast Fisheries Science Center. August 19, 2011.

NEFSC (Northeast Fisheries Science Center). 2012. Data Collection and Analysis in Support of Single and Multispecies Stock Assessments in the Mid-Atlantic: Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program. Supplemental Information Report. December 2012.

Niklitschek, E.J., and D.H. Secor. 2005. Modeling spatial and temporal variation of suitable nursery habitats for Atlantic sturgeon in the Chesapeake Bay. Estuarine and Coastal Shelf Science 64:135-148.

Niklitschek, E.J., and D.H. Secor. 2010. Experimental and field evidence of behavioral habitat selection by juvenile Atlantic (*Acipenser oxyrinchus*) and shortnose (*Acipenser brevirostrum*) sturgeons. Journal of Fish Biology 77:1293-1308.

NMFS (National Marine Fisheries Service). 1995. Endangered Species Act Section 7 consultation on United States Coast Guard vessel and aircraft activities along the Atlantic coast. Biological Opinion. September 15, 1995.

NMFS (National Marine Fisheries Service). 1996. Endangered Species Act Section 7 Consultation on the proposed shock testing of the SEAWOLF submarine off the Atlantic Coast of Florida during the summer of 1997. Biological Opinion. December 12, 1996.

NMFS (National Marine Fisheries Service). 1997. Endangered Species Act Section 7 consultation on Navy activities off the southeastern United States along the Atlantic Coast. Biological Opinion. May 15, 1997.

NMFS (National Marine Fisheries Service). 1998. Second reinitiation of Endangered Species Act Section 7 consultation on United States Coast Guard vessel and aircraft activities along the Atlantic coast. Biological Opinion. June 8, 1998.

NMFS (National Marine Fisheries Service). 2002. Endangered Species Act Section 7 Consultation on Shrimp Trawling in the Southeastern United States, under the Sea Turtle Conservation Regulations and as Managed by the Fishery Management Plans for Shrimp in the South Atlantic and Gulf of Mexico. Biological Opinion. December 2, 2002.

NMFS (National Marine Fisheries Service). 2004a. Endangered Species Act Section 7 Reinitiated Consultation on the Continued Authorization of the Atlantic Pelagic Longline Fishery under the Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (HMS FMP). Biological Opinion. June 1, 2004.

NMFS (National Marine Fisheries Service). 2004b. Endangered Species Act Section 7 Consultation on the Proposed Regulatory Amendments to the Fisheries Management Plan for the Pelagic Fisheries of the Western Pacific. Biological Opinion. February 23, 2004.

NMFS (National Marine Fisheries Service). 2004c. Final Environmental Assessment and Regulatory Impact Review Regulatory Flexibility Act Analysis on Sea Turtle Conservation Measures for the Pound Net Fishery in Virginia Waters of the Chesapeake Bay. Prepared by the National Marine Fisheries Service, Northeast Region. April 2004.

NMFS (National Marine Fisheries Service). 2006. Endangered Species Act Section 7 Consultation on the Proposed Renewal of an Operating License for the Creek Nuclear Generating Station on the Forked River and Oyster Creek, Barnegat Bay, New Jersey. Biological Opinion. November 22, 2006.

NMFS (National Marine Fisheries Service). 2007. Final Environmental Impact Statement for amending the Atlantic Large Whale Take Reduction Plan: broad-based gear modifications. Volume I of II.

NMFS (National Marine Fisheries Service). 2008a. Summary Report of the Workshop on Interactions Between Sea Turtles and Vertical Lines in Fixed-Gear Fisheries. M.L. Schwartz (ed.), Rhode Island Sea Grant, Narragansett, Rhode Island. 54 pp.

NMFS (National Marine Fisheries Service). 2008b. Endangered Species Act Section 7 Consultation on the U.S. Navy Atlantic Fleet's conduct of active sonar training along the Atlantic Coast of the United States and in the Gulf of Mexico from January 2009 to January 2014. Biological Opinion. January 16, 2008.

NMFS (National Marine Fisheries Service). 2009a. Endangered Species Act Section 7 Consultation on U.S. Navy activities in the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2009 to June 2010. Biological Opinion. June 5, 2009.

NMFS (National Marine Fisheries Service). 2009b. Endangered Species Act Section 7 Consultation on the U.S. Navy Atlantic Fleet's conduct of active sonar training along the Atlantic Coast of the United States and in the Gulf of Mexico from January 2009 to January 2010. Biological Opinion. January 21, 2009.

NMFS (National Marine Fisheries Service). 2010. Endangered Species Act Section 7 Consultation on the authorization of fisheries under the Monkfish Fishery Management Plan. Biological Opinion. October 29, 2010.

NMFS (National Marine Fisheries Service). 2011. Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species, October 1, 2008 – September 30, 2010. Washington, D.C.: National Marine Fisheries Service. 194 pp.

NMFS (National Marine Fisheries Service). 2012a. Reinitiation of Endangered Species Act Section 7 Consultation on the Continued Implementation of the Sea Turtle Conservation Regulations, as Proposed to Be Amended, and the Continued Authorization of the Southeast U.S. Shrimp Fisheries in Federal Waters under the Magnuson-Stevens Act. Biological Opinion. May 8, 2012.

NMFS (National Marine Fisheries Service). 2012b. Endangered Species Act Section 7 consultation on n the NEFSC Research Vessel Surveys as well as Two Cooperative Gear Research Studies to be overseen by the NEFSC Protected Species Branch. Biological Opinion. November 30, 2012.

NMFS (National Marine Fisheries Service). 2012c. Endangered Species Act Section 7 Consultation on the Atlantic Sea Scallop Fishery Management Plan. Biological Opinion. July 12, 2012.

NMFS (National Marine Fisheries Service). 2014. Draft Programmatic Environmental Assessment for Fisheries Research Conducted and Funded by the Northeast Fisheries Science Center. December 2014. Prepared by URS Group, Anchorage, Alaska. 657 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1991. Recovery plan for U.S. population of Atlantic green turtle *Chelonia mydas*. Washington, D.C.: National Marine Fisheries Service. 52 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1992. Recovery plan for leatherback turtles *Dermochelys coriacea* in the U.S. Caribbean, Atlantic, and Gulf of Mexico. Washington, D.C.: National Marine Fisheries Service. 65 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. Silver Spring, Maryland: National Marine Fisheries Service. 139 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1998a. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). Silver Spring, Maryland: National Marine Fisheries Service. 84 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1998b. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (*Dermochelys coriacea*). Silver Spring, Maryland: National Marine Fisheries Service. 65 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007a. Loggerhead sea turtle (*Caretta caretta*) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 65 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007b. Kemp's ridley sea turtle *(Lepidochelys kempii*) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 50 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007c. Green sea turtle (*Chelonia mydas*) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 102 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007d. Leatherback sea turtle (*Dermochelys coriacea*) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 79 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2008. Recovery plan for the Northwest Atlantic population of the loggerhead turtle (*Caretta caretta*), Second revision. Washington, D.C.: National Marine Fisheries Service. 325 pp.

NMFS (National Marine Fisheries Service), USFWS (U.S. Fish and Wildlife Service), and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland 156 pp. + appendices.

NRC (National Research Council). 1990. Decline of the Sea Turtles: Causes and Prevention. Washington, D.C.: National Academy Press. 259 pp.

NREFHSC (Northeast Region Essential Fish Habitat Steering Committee). 2002. Workshop on the effects of fishing gear on marine habitat off the northeastern United States. October 23-25, Boston, Massachusetts. NEFSC Reference Document 02-01, 86 pp.

Oakley, N.C. 2003. Status of shortnose sturgeon, *Acipenser brevirostrum*, in the Neuse River, North Carolina. Master's thesis. North Carolina State University, Raleigh, North Carolina.

Palka, D. 2000. Abundance and distribution of sea turtles estimated from data collected during cetacean surveys. Pages 71-72 in K.A. Bjorndal and A.B. Bolten, eds. Proceedings of a workshop on assessing abundance and trends for in-water sea turtle populations. NOAA Technical Memorandum NMFS-SEFSC-445.

Palmer M.A., C.A. Reidy, C. Nilsson, M. Florke, J. Alcamo, P.S. Lake, and N. Bond. 2008. Climate change and the world's river basins: anticipating management options. Frontiers in Ecology and the Environment 6:81-89.

Parmesan, C., and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421:37-42.

Pearce, A.F. 2001. Contrasting population structure of the loggerhead turtle (*Caretta caretta*) using mitochondrial and nuclear DNA markers. Master's thesis, University of Florida. 71 pp.

Pearce, A.F. and B.W. Bowen. 2001. Final report: Identification of loggerhead (*Caretta caretta*) stock structure in the southeastern United States and adjacent regions using nuclear DNA markers. Project number T-99-SEC-04. Submitted to the National Marine Fisheries Service, May 7, 2001. 79 pp.

Pikitch, E.K., P. Doukakis, L. Lauck, P. Chakrabarty and D.L. Erickson. 2005. Status, trends and management of sturgeon and paddlefish fisheries. Fish and Fisheries 6:233-265.

Pritchard, P.C.H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea*, in Pacific, Mexico, with a new estimate of the world population status. Copeia 1982(4):741-747.

Pritchard, P.C.H. 2002. Global status of sea turtles: an overview. Document INF-001 prepared for the Inter-American Convention for the Protection and Conservation of Sea Turtles, First Conference of the Parties (COP1IAC), First part August 6-8, 2002.

Pyzik, L., J. Caddick, and P. Marx. 2004. Chesapeake Bay: introduction to an ecosystem. Chesapeake Bay Program, EPA Publication 903-R-04-003. Annapolis, Maryland.

Rankin-Baransky, K., C.J. Williams, A.L. Bass, B.W. Bowen, and J.R. Spotila. 2001. Origin of loggerhead turtles stranded in the Northeastern United States as determined by mitochondrial DNA analysis. Journal of Herpetology 35:638-646.

Rebel, T.P. 1974. Sea turtles and the turtle industry of the West Indies, Florida and the Gulf of Mexico. Coral Gables, Florida: University of Miami Press.

Reddin, D.G. 2006. Perspectives on the marine ecology of Atlantic salmon (*Salmo salar*) in the Northwest Atlantic. Canadian Science Advisory Secretariat. Research Document 2006/018.

Rees, A.F., A. Saad, and M. Jony. 2005. Marine turtle nesting survey, Syria 2004: discovery of a "major" green turtle nesting area. Page 38 in Book of Abstracts of the Second Mediterranean Conference on Marine Turtles. Antalya, Turkey, 4-7 May 2005.

Revelles, M., C. Carreras, L. Cardona, A. Marco, F. Bentivegna, J.J. Castillo, G. de Martino, J.L. Mons, M.B. Smith, C. Rico, M. Pascual, and A. Aguilar. 2007. Evidence for an asymmetrical size exchange of loggerhead sea turtles between the Mediterranean and the Atlantic through the Straits of Gibraltar. Journal of Experimental Marine Biology and Ecology 349:261-271.

Richardson, A.J., A. Bakun, G.C. Hays, and M.J. Gibbons. 2009. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. Trends in Ecology and Evolution 24:312-322.

Robinson, M.M., H.J. Dowsett, and M.A. Chandler. 2008. Pliocene role in assessing future climate impacts. Eos, Transactions of the American Geophysical Union 89(49):501-502.

Rochard, E., M. Lepage, and L. Meauzé. 1997. Identification et caractérisation de l'aire de répartition marine de l'esturgeon européen *Acipenser sturio* à partir de déclarations de captures. Aquatic Living Resources 10:101-109.

Ross, J.P. 1996. Caution urged in the interpretation of trends at nesting beaches. Marine Turtle Newsletter 74:9-10.

Sarti, L., S.A. Eckert, N. Garcia, and A.R. Barragán. 1996. Decline of the world's largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter 74:2-5.

Sarti, L., S. Eckert, P. Dutton, A. Barragán, and N. García. 2000. The current situation of the leatherback population on the Pacific coast of Mexico and central America, abundance and distribution of the nestings: an update. Pages 85-87 in H. Kalb and T. Wibbels, compilers. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFSC-443.

Sarti Martinez, L., A.R. Barragán, D.G. Munoz, N. Garcia, P. Huerta, and F. Vargas. 2007. Conservation and biology of the leatherback turtle in the Mexican Pacific. Chelonian Conservation and Biology 6(1):70-78.

Sasso, C.R., and S.P. Epperly. 2006. Seasonal sea turtle mortality risk from forced submergence in bottom trawls. Fisheries Research 81:86-88.

Savoy, T. 2007. Prey eaten by Atlantic sturgeon in Connecticut waters. American Fisheries Society Symposium 56:157-165.

Savoy, T., and D. Pacileo. 2003. Movements and habitats of subadult Atlantic sturgeon in Connecticut waters. Transactions of the American Fisheries Society 131:1-8.

Schmid, J.R., and W.N. Witzell. 1997. Age and growth of wild Kemp's ridley turtles (*Lepidochelys kempi*): cumulative results of tagging studies in Florida. Chelonian Conservation and Biology 2(4):532-537.

Schueller, P., and D.L. Peterson. 2006. Population status and spawning movements of Atlantic sturgeon in the Altamaha River, Georgia. Presentation to the 14th American Fisheries Society Southern Division Meeting, San Antonio, February 8-12th, 2006.

Schultz, J.P. 1975. Sea turtles nesting in Surinam. Zoologische Verhandelingen (Leiden) 143:3-172.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184:80-82.

Scott, W.B., and M.G. Scott. 1988. Atlantic Fishes of Canada. University of Toronto Press, Toronto, Canada.

Sears, R., and J. Calambokidis. 2002. COSEWIC Assessment and update status report on the blue whale *Balaenoptera musculus*, Atlantic population and Pacific population, in Canada. Ottawa: Committee on the Status of Endangered Wildlife in Canada. 38 pp.

Secor, D.H. 2002. Atlantic sturgeon fisheries and stock abundances during the late nineteenth century. American Fisheries Society Symposium 28:89-98.

Secor, D.H., and J.R. Waldman. 1999. Historical abundance of Delaware Bay Atlantic sturgeon and potential rate of recovery. American Fisheries Society Symposium 23:203-216.

SEFSC (Southeast Fisheries Science Center). 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-455. 343 pp.

SEFSC (Southeast Fisheries Science Center). 2009. An assessment of loggerhead sea turtles to estimate impacts of mortality reductions on population dynamics. NMFS SEFSC Contribution PRD-08/09-14. 45 pp.

Sella, I. 1982. Sea turtles in the Eastern Mediterranean and Northern Red Sea. Pages 417-423 in K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Washington, D.C.: Smithsonian Institution Press.

Seminoff, J.A. 2004. *Chelonia mydas*. In 2012 IUCN Red List of Threatened Species. Version 2012.2. Accessed 23 May 2013. http://www.iucnredlist.org/details/4615/0.

Seney, E.E., and J.A. Musick. 2007. Historical diet analysis of loggerhead sea turtles (*Caretta caretta*) in Virginia. Copeia 2007(2):478-489.

Shaffer, M.L. 1981. Minimum population sizes for species conservation. BioScience 31(2):131-134.

Shamblin, B.M. 2007. Population structure of loggerhead sea turtles (*Caretta caretta*) nesting in the southeastern United States inferred from mitochondrial DNA sequences and microsatellite loci. Master’s thesis, University of Georgia. 59 pp.

Shirey, C.A., C.C. Martin, and E.J. Stetzar. 1999. Atlantic sturgeon abundance and movement in the lower Delaware River. Final Report. NOAA Project No. AGC-9N, Grant No. A86FAO315. Dover: Delaware Division of Fish and Wildlife.

Shoop, C.R. 1987. The Sea Turtles. Pages 357-358 in R.H. Backus and D.W. Bourne, eds. Georges Bank. Cambridge, Massachusetts: MIT Press.

Shoop, C.R., and R.D. Kenney. 1992. Seasonal distributions and abundance of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetological Monographs 6:43-67.

Shoop, C.R., and C.A. Ruckdeschel. 1989. Long-distance movement of a juvenile loggerhead sea turtle. Marine Turtle Newsletter 47:15.

Short, F.T., and H.A. Neckles. 1999. The effects of global climate change on seagrasses. Aquatic Botany 63:169-196.

Smith, T.I.J. 1985. The fishery, biology, and management of Atlantic sturgeon, *Acipenser oxyrhynchus*, in North America. Environmental Biology of Fishes 14(1):61-72.

Smith, T.I.J., and E.K. Dingley. 1984. Review of biology and culture of Atlantic (*Acipenser oxyrhynchus*) and shortnose sturgeon (*A. brevirostrum*). Journal of World Mariculture Society 15:210-218.

Smith, T.I.J., and J.P. Clugston. 1997. Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. Environmental Biology of Fishes 48:335-346.

Smith, T.I.J., E.K. Dingley, and D.E. Marchette. 1980. Induced spawning and culture of Atlantic sturgeon. Progressive Fish-Culturist 42:147-151.

Smith, T.I.J., D.E. Marchette, and R.A. Smiley. 1982. Life history, ecology, culture and management of Atlantic sturgeon, *Acipenser oxyrhynchus oxyrhynchus,* Mitchill, in South Carolina. South Carolina Wildlife Marine Resources. Resources Department, Final Report to U.S. Fish and Wildlife Service Project AFS-9. 75 pp.

Snover, M.L., A.A. Hohn, L.B. Crowder, and S.S. Heppell. 2007. Age and growth in Kemp's ridley sea turtles: evidence from mark-recapture and skeletochronology. Pages 89-106 in P.T. Plotkin, ed. Biology and Conservation of Ridley Sea Turtles. Baltimore, Maryland: Johns Hopkins University Press.

Soulé, M.E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Pages 151-170 in M.E. Soule and B.A. Wilcox, eds. Conservation Biology: An Evolutionary-Ecological Perspective. Sunderland, Massachusetts: Sinauer.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? Chelonian Conservation and Biology 2:209-222.

Spotila, J.R., R.D. Reina, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature 405:529-530.

Squiers, T. 2004. State of Maine 2004 Atlantic sturgeon compliance report to the Atlantic States Marine Fisheries Commission. Report submitted to Atlantic States Marine Fisheries Commission, December 22, 2004, Washington, D.C.

Squiers, T., M. Smith, and L. Flagg. 1979. Distribution and abundance of shortnose and Atlantic sturgeon in the Kennebec River Estuary. Maine DMR Report, 51 pp.

Squiers, T., L. Flagg, M. Smith, K. Sherman, and D. Ricker. 1981. Annual Progress Report: American shad enhancement and status of sturgeon stocks in selected Maine waters. May 1, 1980 to April 30, 1981. Maine DMR Project AFC-20.

Squiers, T.S., Jr. 1998. Progress Report: Kennebec River shortnose sturgeon population study. August-December 1998. NMFS Contract 40 EANF800053.

Stabenau, E.K., T.A. Heming, and J.F. Mitchell. 1991. Respiratory, acid-base and ionic status of Kemp's ridley sea turtles (*Lepidochelys kempi*) subjected to trawling. Comparative Biochemistry and Physiology 99A(½):107-111.

Stetzar, E.J. 2002. Population Characterization of Sea Turtles that Seasonally Inhabit the Delaware Estuary. Master of Science thesis, Delaware State University, Dover, Delaware. 136 pp.

Stevenson, J.T., and D.H. Secor. 1999. Age determination and growth of Hudson River Atlantic sturgeon, *Acipenser oxyrinchus*. Fishery Bulletin 97:153-166.

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004a. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. Transactions of the American Fisheries Society 133:527-537.

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004b. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the Northeast United States. North American Journal of Fisheries Management 24:171-183.

Stewart, K., C. Johnson, and M.H. Godfrey. 2007. The minimum size of leatherbacks at reproductive maturity, with a review of sizes for nesting females from the Indian, Atlantic and Pacific Ocean basins. Herpetological Journal 17:123-128.

Stewart, K., M. Sims, A. Meylan, B. Witherington, B. Brost, and L.B. Crowder. 2011. Leatherback nests increasing significantly in Florida, USA; trends assessed over 30 years using multilevel modeling. Ecological Applications 21(1):263-273.

Suárez, A. 1999. Preliminary data on sea turtle harvest in the Kai Archipelago, Indonesia. Abstract, 2nd ASEAN Symposium and Workshop on Sea Turtle Biology and Conservation, July 15-17, 1999, Sabah, Malaysia.

Suárez, A., P.H. Dutton, and J. Bakarbessy. 2000. Leatherback (*Dermochelys coriacea*) nesting on the North Vogelkop Coast of Irian Jaya, Indonesia. Page 260 in H.J. Kalb and T. Wibbels, compilers. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443.

Sweka, J.A., J. Mohler, M.J. Millard, T. Kehler, A. Kahnle, K. Hattala, G. Kenney, and A. Higgs. 2007. Juvenile Atlantic sturgeon habitat use in Newburgh and Haverstraw bays of the Hudson River: Implications for population monitoring. North American Journal of Fisheries Management 27:1058-1067.

Taub, S.H. 1990. Interstate fishery management plan for Atlantic sturgeon. Fisheries Management Report No. 17. Atlantic States Marine Fisheries Commission, Washington, D.C. 73 pp.

TEWG (Turtle Expert Working Group). 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409:1-96.

TEWG (Turtle Expert Working Group). 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444:1-115.

TEWG (Turtle Expert Working Group). 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555:1-116.

TEWG (Turtle Expert Working Group). 2009. An assessment of the loggerhead turtle population in the Western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575:1-131.

Thompson, N.B. 1984. Progress report on estimating density and abundance of marine turtles: results of first year pelagic surveys in the Southeast U.S. Miami, Florida: National Marine Fisheries Service. 64 pp.

Thompson, N.B. 1988. The status of loggerhead, *Caretta caretta*; Kemp's ridley, *Lepidochelys kempi*; and green, *Chelonia mydas* sea turtles in U.S. waters. Marine Fisheries Review 50(3):16-23.

Thompson, N.B., and H. Huang. 1993. Leatherback turtles in southeast U.S. waters. NOAA Technical Memorandum NMFS-SEFSC-318:1-25.

Titus, J.G., and V.K. Narayanan. 1995. The Probability of Sea Level Rise. EPA 230-R-95-008. Washington, D.C.: U.S. Environmental Protection Agency. 186 pp.

Torn, M., and J. Harte. 2006. Missing feedbacks, asymmetric uncertainties, and the underestimation of future warming. Geophysical Research Letters 33:L10703. doi:10.1029/2005GL025540.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1992. Recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). St. Petersburg, Florida: National Marine Fisheries Service.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. Endangered Species Act Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences. Washington, D.C.: USFWS and NMFS.

Van den Avyle, M.J. 1984. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Atlantic): Atlantic sturgeon. U.S. Fish and Wildlife Service Biological Services Program FWS/OBS 82(11.25). 17 pp.

Van Eenennaam, J.P., and S.I. Doroshov. 1998. Effects of age and body size on gonadal development of Atlantic sturgeon. Journal of Fish Biology 53:624-637.

Van Eenennaam, J.P., S.I. Doroshov, G.P. Moberg, J.G. Watson, D.S. Moore and J. Linares. 1996. Reproductive conditions of the Atlantic sturgeon (*Acipenser oxyrhynchus*) in the Hudson River. Estuaries 19:769-777.

Van Houtan, K.S. and J.M. Halley. 2011. Long-Term Climate Forcing in Loggerhead Sea Turtle Nesting. PLoS ONE 6(4): e19043. doi:10.1371/journal.pone.0019043.

Vargo, S., P. Lutz, D. Odell, E. Van Vleep, and G. Bossart. 1986. Final report: Study of effects of oil on marine turtles. Technical Report. OCS study MMS 86-0070. Volume 2. 181 pp.

VIMS (Virginia Institute of Marine Science). 2010. Environmental Assessment for Data Collection and Analysis in Support of Single and Multispecies Stock Assessments in the Mid-Atlantic: Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program – 2010-2012. Prepared for the National Marine Fisheries Service, Northeast Region. 102 pp.

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidea. Pages 24-60 in Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(Part III). xxi + 630 pp.

Waldman, J.R., J.T. Hart, and I.I. Wirgin. 1996. Stock composition of the New York Bight Atlantic sturgeon fishery based on analysis of mitochondrial DNA. Transactions of the American Fisheries Society 125: 364-371.

Wallace, B.P., S.S. Heppell, R.L. Lewison, S. Kelez, and L.B. Crowder. 2008. Reproductive values of loggerhead turtles in fisheries bycatch worldwide. Journal of Applied Ecology 45:1076-1085.

Warden, M.L. 2011a. Modeling loggerhead sea turtle (*Caretta caretta*) interactions with US Mid-Atlantic bottom trawl gear for fish and scallops, 2005-2008. Biological Conservation 144:2202-2212.

Warden, M.L. 2011b. Proration of loggerhead sea turtle (*Caretta caretta*) interactions in U.S. Mid-Atlantic bottom otter trawls for fish and scallops, 2005-2008, by managed species landed. NEFSC Reference Document 11-04. 8 pp.

Warden, M., and K. Bisack. 2010. Analysis of Loggerhead Sea Turtle Bycatch in Mid-Atlantic Bottom Trawl Fisheries to Support the Draft Environmental Impact Statement for Sea Turtle Conservation and Recovery in Relation to Atlantic and Gulf of Mexico Bottom Trawl Fisheries. NEFSC Reference Document 10-08. 13 pp.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2012. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2011. NOAA Technical Memorandum NMFS-NE-221:1-319.

Wehrell, S. 2005. A survey of the groundfish caught by the summer trawl fishery in Minas Basin and Scots Bay. Honours Thesis. Acadia University, Wolfville, Canada.

Welsh, S.A., M.F. Mangold, J.E. Skjeveland, and A.J. Spells. 2002. Distribution and Movement of Shortnose Sturgeon (*Acipenser brevirostrum*) in the Chesapeake Bay. Estuaries 25(1):101-104.

Whitehead, H. 2002. Sperm whale, *Physeter macrocephalus*. Pages 1165-1172 in W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego: Academic Press.

Wibbels, T. 2003. Critical approaches to sex determination in sea turtle biology and conservation. Pages 103-134 in P.L. Lutz, J.A. Musick, and J. Wyneken, eds. Biology of Sea Turtles, Volume 2. Boca Raton: CRC Press.

Wirgin, I., and T. King. 2011. Mixed Stock Analysis of Atlantic sturgeon from coastal locales and a non-spawning river. Presented at February 2011 Atlantic and shortnose sturgeon workshop.

Wirgin, I., J.R. Waldman, J. Rosko, R. Gross, M.R. Collins, S.G. Rogers, and J. Stabile. 2000. Genetic structure of Atlantic sturgeon populations based on mitochondrial DNA control region sequences. Transactions of the American Fisheries Society 129:476-486.

Wirgin, I., L. Maceda, J.R. Waldman, S. Wehrell, M. Dadswell, and T. King. 2012. Stock origin of migratory Atlantic sturgeon in the Minas Basin, Inner Bay of Fundy, Canada, determined by microsatellite and mitochondrial DNA analyses. Transactions of the American Fisheries Society 141:1389-1398.

Witherington, B., P. Kubilis, B. Brost, and A. Meylan. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19:30-54.

Witt, M.J., A.C. Broderick, D.J. Johns, C. Martin, R. Penrose, M.S. Hoogmoed, and B.J. Godley. 2007. Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic. Marine Ecology Progress Series 337:231-243.

Witzell, W.N. 2002. Immature Atlantic loggerhead turtles (*Caretta caretta*): suggested changes to the life history model. Herpetological Review 33(4):266-269.

Witzell, W.N., A.L. Bass, M.J. Bresette, D.A. Singewald, and J.C. Gorham. 2002. Origin of immature loggerhead turtles (*Caretta caretta*) from Hutchinson Island, Florida: evidence from mtDNA markers. Fishery Bulletin 100:624-631.

Wynne, K., and M. Schwartz. 1999. Guide to marine mammals and turtles of the U.S. Atlantic and Gulf of Mexico. Narragansett: Rhode Island Sea Grant.

Young, J.R., T.B. Hoff, W.P. Dey, and J.G. Hoff. 1988. Management recommendations for a Hudson River Atlantic sturgeon fishery based on an age-structured population model. Pages 353-365 in C.L. Smith, ed. Fisheries Research in the Hudson River. Albany: State University of New York Press.

Zug, G.R., and J.F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea*: a skeletochronological analysis. Chelonian Conservation and Biology 2(2):244-249.

Zurita, J.C., R. Herrera, A. Arenas, M.E. Torres, C. Calderon, L. Gomez, J.C. Alvarado, and R. Villavicencio. 2003. Nesting loggerhead and green sea turtles in Quintana Roo, Mexico. Pages 125-127 in J.A. Seminoff, compiler. Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

APPENDIX A

Table 2.2-1 Summary Description of Long-Term NEFSC-Affiliated Research Activities Conducted under the Status Quo Alternative

Many surveys use more than one gear type; each survey/research project is listed under one predominant gear type to avoid duplication or splitting projects into multiple components in the table. See Appendix A for descriptions of the different gear types and vessels used. Appendix B includes figures showing the spatial/temporal distribution of fishing gears used during NEFSC research. Mitigation measures are described in Section 2.2.1. Units of measurement are presented in the format data was collected. Abbreviations used in the table: ADCP = Acoustic Doppler Current Profiler; CTD = Conductivity Temperature Depth; DAS = days at sea; cm^2 = square centimeter; freq = frequency; ft = feet; GB = Georges Bank; GOM = Gulf of Maine; hr = hour; in = inch; kHz = kilohertz; km = kilometer; kts = knots; L = liter; m = meter; m^3 = cubic meter; MAB = Mid-Atlantic Bight; max = maximum; MHz = megahertz; mi = miles; min = minutes; mm = millimeter; NA = Not Available or Not Applicable; nm = nautical miles; SNE = Southern New England; TBD = to be determined; v = volt; yr = year; ~ = approximately.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
NORTHEAST US CONTINENTAL SHELF LME								
Projects using bottom trawl gear								
Benthic Habitat Survey	The objective of this project is to assess habitat distribution and condition, including disturbance by commercial fishing and changes as the benthic ecosystem recovers from chronic fishing impacts. Also serves to collect data on seasonal migration of benthic species, collect bottom data for mapping, and provide indications of climate change through species shifts.	GB	Summer or Fall, Annually 20 DAS	R/V *H.B. Bigelow*, R/V *Gordon Gunter*, or R/V *Pisces*	4-seam, 3-bridle bottom trawl	Net size: 31 m long x 19 m wide x 5 m high Tow speed: 3.0 kts Duration: 30 min at target depth	54 tows (maximum)	**Standard Avoidance:** Vessel captains and crew watch for marine mammals and sea turtles while underway, especially where concentrations of protected species are observed, and take action to avoid collisions if possible (see Section 2.2.3). **Move-on Rule:** Vessel captains and Chief Scientists take action to avoid setting gear at times and places where concentrations of protected species are observed to avoid potential interactions with gear (see Section 2.2.4).
					Conductivity Temperature Depth (CTD) profiler and rosette water sampler	Tow Speed: 0 Duration: 5-15 min	217 casts (maximum)	
					Brooke Ocean Moving Vessel CTD Profiler	Tow speed: 10 kts	Continuous	
					Van Veen Sediment Grab aboard SeaBoss	Samples a 100 cm^2 area Tow speed: 0 Duration: 1 min	128 casts (maximum)	
					Plankton Light Trap	Size: 0.027 m^3 Tow speed: 0 Duration: 30 min	10 casts (maximum)	
					Beam trawl	Net size: 2 m wide Tow speed : 2.0 kts Duration: 20 min at depth	50 tows	
					Naturalists dredge	1 m wide Tow speed: 2-3 kts Duration: 1 min at depth	3 casts	
					SeaBoss Benthic Camera Vehicle	Still and video cameras, strobe & continuous lighting, CTD Tow Speed: 0.5 kt Duration: 30 min	128 tows (maximum)	
					Reson 7125 swath sonar	Output freq: 200/400 kHz	Continuous	
					Klein 5500 side scan sonar	Output freq: 450 kHz	Continuous	
					Odum CV200 Single beam sonar	Output freq: 200 kHz	Continuous	
					Split Beam Sonar	Output freq: 18 kHz, 38 kHz, 120 kHz	Continuous	

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Changes in the Community Structure of Benthic Fishes	The objective of this project is to quantify the abundance and distribution of benthic associated fishes of the Hudson River Estuary ecosystem.	Hudson River Estuary, New York.	Summer 20 DAS	R/V *Nauvoo*	16 ft bottom trawl	Net size: 16 ft wide bottom trawl Tow speed: 2.5 kts Duration: 5 min	176 trawls	Standard Avoidance and Move-on Rule
					YSI (electronic water chemistry sensor)	YSI 6000		
					Hydroacoustic instrument	38 and 120 kHz split-beam		
					Kemmerer bottle	2.2 L		
Fish Collection for Laboratory Experiments	Trawling/hook and line collection operations undertake to capture high quality fish for laboratory experiments.	New York Bight, Sandy Hook Bay, New Jersey	Annually, as needed throughout year 10 DAS	R/V *Nauvoo*, R/V *Harvey*, R/V *Chemist*	Simple Memphis net and twine shrimp trawl	Net size: 16 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min	Varies depending on scientific need, typically enough trawls to capture 10-60 specimens	Standard Avoidance and Move-on Rule
					Simple Memphis net and twine shrimp trawl	Net size: 30 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min		
					Fishing poles	Fishing poles		
Habitat Characterization	The key objective of this project is to characterize and map coastal marine habitats and living marine resources, particularly in waters and wetlands of New York and New Jersey. The research is conducted under the terms of a Memorandum of Understanding with the NJ Sea Grant Consortium.	Sandy Hook Bay Barnegat Bay, New York and New Jersey	Annually 30 DAS	R/V *Nauvoo*, R/V *Resolute*	Simple Memphis net and twine shrimp trawl	Net size: 16 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min	Max. 60 trawls per year with 16 ft net and 20 trawls per year with 30 ft net	Standard Avoidance and Move-on Rule
					Simple Memphis net and twine shrimp trawl	Net size: 30 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min		
					Video Sled	Sea Cam 5000 12v video cam		
					CTD	Sea Bird CTD		
					YSI	YSI 6000		
					Tucker plankton net	1.4 m x 1 m trawl		
					Acoustic Doppler Current Profiler (ADCP)	Output freq. 600 kHz		
					Hydroacoustic instrument	38 and 120 kHz split-beam		
					Ponar grab	6 in x 6 in		
					Kemmerer bottle	2.2 L		
Habitat Mapping Survey	This project maps shallow reef habitats of fisheries resource species, including warm season habitats of black sea bass, and locate sensitive habitats (e.g. shallow temperate coral habitats) for habitat conservation.	Ocean shelf off Maryland Coast	Summer, Annually 11 DAS	R/V *F.R. Hassler*	4-seam, 3-bridle bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed: 3.0 kts Duration: 30 min at target depth	54 tows (max)	Standard Avoidance and Move-on Rule
					CTD Profiler	Tow Speed: 0 Duration: 5-15 min	217 casts (max)	
					Brooke Ocean Moving Vessel CTD Profiler	Tow speed 10 kts	Continuous	
					Van Veen Sediment Grab aboard SeaBoss	Samples 100 cm^2 area Tow speed: 0 Duration: 1 min	128 casts (max)	
					Plankton Light Trap (optional)	Size: 0.027 m^3 Tow speed: 0 Duration: 30 min	10 casts (max)	

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Beam trawl,	Net size: 2 m wide Tow speed: 2.0 kts Duration: 20 min at depth	50 tows	
					Naturalists dredge	1 m wide Tow speed: 2-3 kts Duration: 1 min at depth	3 casts	
					SeaBoss Benthic Camera Vehicle	Still and video cameras, strobe & continuous lighting, CTD Tow Speed: 0.5 kt Duration: 30 min	128 tows (max)	
					Reson 7125 swath sonar	Output freq: 200/400 kHz	Continuous	
					Klein 5500 side scan sonar	Output freq: 450 kHz	Continuous	
					Odum CV200 Single beam sonar	Output freq: 200 kHz	Continuous	
					Split Beam Sonar	Output freq: 18 kHz, 38 kHz, 120 kHz	Continuous	
Living Marine Resources Center Survey	This project undertakes to determine the distribution, abundance, and recruitment patterns for multiple species.	Cape Hatteras to New Jersey	Winter, Annually 11 DAS	R/V *H.B. Bigelow*, R/V *Gordon Gunter*, or R/V *Pisces*	4-seam, 3-bridle bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed: 3.8 kts Duration: 30 min at depth	25 tows	Standard Avoidance and Move-on Rule
					Beam trawl	Net size: 2 m wide Tow speed: 2.0 kts Duration: 20 min at depth	30 tows	
					Van Veen sediment grab	Samples 100 cm^2 area Duration: 1 min	29 casts	
					CTD Profiler	Tow Speed: 0 Duration: 15-120 min	30 casts	
					Split Beam Sonar	Output freq: 18, 38,120 kHz	Continuous	
Massachusetts Division of Marine Fisheries Bottom Trawl Surveys	The objective of this project is to track mature animals and determine juvenile abundance.	Territorial waters from Rhode Island to New Hampshire borders	Spring and Fall 30-36 DAS	R/V *G. Michelle*	Otter Trawl	Net size: 39 ft headrope, 51 ft footrope Tow speed: 2.5 kts Duration: 20 min	In Gulf of Maine (GOM), 56 tows in spring and 56 tows in fall. In Southern New England (SNE), 47 tows in spring and 47 tows in fall. 206 tows total/yr	Standard Avoidance and Move-on Rule

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program	This project provides data collection and analysis in support of single and multispecies stock assessments in the Mid-Atlantic. It includes the Maine/New Hampshire inshore trawl program, conducted by Maine Department of Marine Resources (MDMR) in the northern segment, and the NEAMAP Mid-Atlantic to Southern New England survey, conducted by Virginia Institute of Marine Science, College of William and Mary (VIMS) in the southern segment.	Near shore Maine to North. Carolina Northern segment: U.S.-Canada border to New Hampshire-Massachusetts border from shore to 300 ft depth. Southern segment: Montauk, New York to Cape Hatteras, North. Carolina from 20 to 90 ft depth.	Spring (Apr.–June) and Fall (Oct.–Dec.) approximately 30-50 DAS per season for each segment.	F/V *Robert Michael* from Maine to New Hampshire (northern segment) F/V *Darana R* from Massachusetts to North Carolina (southern segment)	Northern segment: modified GOM shrimp otter trawl net typically used by commercial otter trawlers in Maine and New Hampshire. Southern segment: 4-seam, 3-bridle net bottom trawl (same net used by NEFSC Standard Bottom Trawl Survey).	Northern segment: Net size: 58 ft headrope, 70 ft footrope, 24 ft siderope, 1 in poly stretch mesh, with #7.5 Bison doors Tow speed: 2.2-2.5 kts Duration: 20 min at target depth Southern segment: Net size: 31 m x 19 m x 5 m Tow speed: 3 kts Duration: 20 min at target depth	Northern segment: 100 tows per season, 200 tows per year, approx. 1 station per 36 square nm. Southern segment: 150 tows per season, 300 tows per year, approx. 1 station per 30 square nm	Daytime tows only in both northern and southern NEAMAP segments. In northern segment, each tow station is surveyed for lobster gear prior to setting out mobile trawl gear, during which the bridge crew also observe for protected species. Move-on Rule.
Northeast Observer Program (NEFOP) Observer Bottom Trawl Training Trips	Certification training for new NEFOP Observers is provided by this operation.	Maine to North Carolina	Annually, one-day trips throughout year as needed. 18 DAS	Contracted commercial fishing vessels	Contracted vessels trawl gear	Net size: various Tow speed: various Duration: 20-45 min per tow	6 tows per trip 108 tows total	Continuous watch for marine mammals and sea turtles by vessel crew and NEFOP staff while underway and take action to avoid setting gear at times and places where concentrations of protected species are observed.
Northern Shrimp Survey	The objective of this project is to determine the distribution and abundance of northern shrimp and collect related data.	GOM	Annually 22 DAS	R/V *G. Michelle*	4-seam modified commercial shrimp bottom trawl. Positional sensors, mini-log, and CTD attached to net gear.	Net size: 25 m x 17 m x 3 m Tow speed: 2 kts Duration: 15 min	82 tows	Standard Avoidance and Move-on Rule
NEFSC Standard Bottom Trawl Surveys (BTS)	This project track mature animals and determines juvenile abundance over their range of distribution.	Cape Hatteras to Western Scotian Shelf	Spring & fall 120 DAS	R/V *H.B. Bigelow*	4-seam, 3-bridle net bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed: 3 kts Duration: 20 min at target depth	GOM: 110 tows each season (220 total) Georges Bank (GB): 90 tows each season (180 total) SNE: 90 tows each season (180 total) Mid-Atlantic Bight (MAB): 110 tows each season (220 total)	Standard Avoidance and Move-on Rule
					CTD Profiler	Tow speed: 0 Duration: 2-5 hr	800 tows	
					ADCP	300 or 150 kHz	Continuous	
					Bongo net equipped with CTD	61 cm diameter Tow type: oblique Tow speed: 1.5 kts Duration: max 20 min	240 tows	
					Split beam and multi-beam acoustics	Output freq: 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz	Continuous	

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Projects using pelagic trawl gear								
Atlantic Herring Survey	This operation collects fisheries-independent herring spawning biomass data and also includes survey equipment calibration and performance tests.	GOM and Northern GB	Fall 34 DAS	R/V *H.B. Bigelow*, R/V *Gordon Gunter*, or R/V *Pisces*	4-seam, 3-bridle bottom trawl	31 m x 19 m x 5 m Tow Speed: 3 kts Duration 10-20 min on bottom	20 tows	Standard Avoidance and Move-on Rule
					Hydroacoustic Midwater Rope Trawl	Net size: 15 m x 30 m Tow speed : 4 kts Duration: 5-30 min at depth	70 tows	
					Split beam and multi-beam acoustics	Output Freq: 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz	Continuous	
Atlantic Salmon Trawl Survey	This is a targeted research effort to evaluate the marine ecology of Atlantic salmon.	Inshore and offshore GOM	Spring - annually as funding allows Approx. 21 DAS	Contracted commercial vessels	Modified mid-water trawl that fishes at the surface via pair trawling	Net size: 50 m from wing to wing, 10 m from headrope to footrope Tow speed: 2-6 kts Duration: 30-60 min	Approximately 130 tows	Standard Avoidance and Move-on Rule
Deepwater Biodiversity	This project collects fish, cephalopod and crustacean specimens from 500 to 2000 m for tissue samples, specimen photos, and documentation of systematic characterization.	Western North Atlantic	Annually 16 DAS	R/V *H.B. Bigelow* or R/V *Pisces*	Superior Midwater trawl	Net size: 92 m x 35 m x 31 m Tow speed : 1.5-2.5 kts Duration: 60 min at depth	16 tows	Standard Avoidance and Move-on Rule
					4-seam, 3-bridle bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed : 1.5-2.5 kts Duration: 60 min at depth	9 tows	
					Split beam and multi-beam acoustics	Output Freq: 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz	Continuous	
Penobscot Estuarine Fish Community and Ecosystem Survey	The objective of this project is fish and invertebrate sampling for biometric and population analysis of estuarine and coastal species.	Penobscot Estuary and Bay, Maine	Year round, even coverage across seasons. 12 DAS	Contracted commercial vessels	Mamou shrimp trawl modified to fish at surface	Net size: 12 m x 6 m trawl mouth opening Tow speed: 2-4 kts Duration: 20 min	50 trawls per season (200 trawl total)	Standard Avoidance and Move-on Rule
Projects using longline gear								
Apex Pelagic Shark (***Survey not continued in the Preferred Alternative***)	The NEFSC conducts a bi-annual fishery-independent survey of Atlantic pelagic sharks in U.S. waters from Maryland to Canada. The objectives are to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration and age validation studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for other studies. The time-series of abundance from this survey is critical to the evaluation of pelagic Atlantic shark species.	Maryland to Canada	Biannual in spring 30 DAS Daytime sets only	Charter Vessel	Yankee longline gear and current pelagic longline gear	Both: Mainline length: 2-11 mi Hooks per set: 100-400 Bait: spiny dogfish Soak time: 3-5 hr Yankee: Gangion length: 24 ft Gangion spacing: 170 ft Hook size and type: Non-stainless Japanese #40 tuna hook or non-stainless circle hook Commercial: Gangion length: 33 ft Gangion spacing: 183 ft Hook size and type: Non-stainless circle hook 16/0 or 18/0	25 sets per survey	Prior to setting the gear, the area for the set is visually examined for the presence of sea turtles and marine mammals for at least 30 minutes. If any sea turtles or marine mammals are seen and they appear to be at risk of interactions with the longline gear, the station is moved at least one mile away (Move-on Rule for longline research). During the soak the line is run and if a sea turtle or marine mammal is sighted the line is pulled immediately. In addition, the Chief Scientist, at a minimum, is a NEFOP trained sampler and tagger for sea turtles for the NEFSC.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Apex Predators Bottom Longline Coastal Shark	The NEFSC conducts a bi-annual fishery-independent survey of Atlantic large and small coastal sharks in U.S. waters from Florida to Delaware. The objectives are to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration and age validation studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for other studies. The time-series of abundance from this survey is critical to the evaluation of coastal Atlantic shark species.	Rhode Island to Florida within 40 fathoms	Biannual in spring 47 DAS	Charter Vessel	Florida style bottom longline	Mainline length: 4 mi Gangion length: 12 ft Gangion spacing: 60 ft Hook size and type: Mustad #349703 3/0 non-stainless J hook Hooks per set: 300 Bait: spiny dogfish Soak time: 3 hr	29 sets (max) in MAB	Move-on Rule (this survey uses a one nautical mile radius around the vessel to guide the decision on whether the animals are at risk of interactions). During the soak the line is run and if any sea turtles or marine mammals are sighted the line is pulled immediately. In addition, the Chief Scientist, at a minimum, is a NEFOP trained sampler and tagger for sea turtles for the NEFSC.
Apex Predators Pelagic Nursery Grounds Shark	This project is an opportunistic sampling on board a commercial swordfish longline vessel to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration and age validation studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for other studies. Data from this survey are critical to the evaluation of juvenile pelagic Atlantic shark species. The project determines the location of shark nurseries, species composition, relative abundance, distribution, and migration patterns.	GB to Grand Banks off Newfoundland, Canada	Annually, fall 21-55 DAS	F/V *Eagle Eye II*	Standard commercial pelagic longline gear. Configured according to NMFS HMS Regulations	Mainline length: 35 mi Gangion length: 33 ft Gangion spacing: 183 ft Hook size and type: Non-stainless 18/0 10 degree offset circle Hooks per set: 1008 Bait: spiny dogfish Soak time: 8 hr	Average 21 sets	Move-on Rule. As per required for commercial longline vessels, Captain is trained in NMFS/Highly Migratory Species Protected Species Safe Handling, Release, and Identification Workshops to review mitigation methods required by various take reduction plans as well as methods to release protected species safely.
Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Longline and Gillnet Surveys	This project determines the location of shark nurseries, species composition, relative abundance, distribution, and migration patterns. It is used to identify and refine essential fish habitat and provides standardized indices of abundance by species used in multiple species specific stock assessments. NEFSC conducts surveys in Delaware, New Jersey, and Rhode Island estuarine and coastal waters. Other areas are surveyed by cooperating institutions and agencies. In the NE LME, cooperating partners are Stony Brook University (SBU) in NY and Virginia Institute of Marine Science (VIMS).	Florida to Rhode Island	Annually, summer. 25 DAS for NEFSC conducted surveys. 40 DAS for cooperating institutions and agencies. Daytime sets only	R/V *C.E. Stillwell* and cooperating partner vessels	Bottom longline gear	Small juvenile gear / Large juvenile-adult shark gear Mainline length: 1000 ft / 1000 ft Gangion length: 5 ft / 8 ft Gangion spacing: 20 ft / 40 ft Hook size and type: 12/0 / 16/0 Mustad circle hooks Hooks per set: 50 / 25 Bait: finfish (mackerel or herring) Soak time: 30 min / 2 hr	NEFSC: 20 sets off coast of RI (SNE), 110 sets off coasts of DE and NJ (MAB). SBU: 30 sets off coast of NY. VIMS: 100 sets off coast of VA.	Move-on Rule. The gear is monitored during the soak; if any sea turtles or marine mammals are sighted during the soak and is considered to be at risk of interacting with the gear then the line is pulled immediately.
					Anchored Sinking Gillnet	325 ft x 10 ft, single panel of 4 in stretch mesh made of #177 (20 lb test) nylon monofilament 3 hr soak time while continuously running the net to tag and release targeted species and release all other species.	12 sets (max) in Delaware Bay (NEFSC)	

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Projects using dredge gear								
Annual Assessments of Sea Scallop Abundance and Distribution in Selected Closed/Rotational Areas	These Atlantic Sea Scallop Research Set-Aside rotational area surveys endeavor to monitor scallop biomass and derive estimates of Total Allowable Catch (TAC) for annual scallop catch specifications. Additionally, the surveys monitor recruitment, growth, and other biological parameters such as meat weight, shell height and gonadal somatic indices.	Dredge and drop camera samples in GB, Closed Areas I & II, Hudson Canyon, DELMarVA, Nantucket, GOM and Mid-Atlantic areas. Drop camera also samples in GOM: Fippennies Ledge, Cashes Ledge, Platts Bank and Jeffreys Ledge	Dredge surveys conducted Apr. through Sept. HABCAM and drop camera surveys generally occur in Summer months (June – Sept.) Not all rotational areas are sampled each year. Typically, between 2 to 4 areas are selected for dredge surveys and 2-3 areas for HABCAM or drop camera surveys are selected each year.	Dredge surveys: F/V *Celtic*, F/V *Pursuit*, F/V *Nordic Pride*, F/V *Kathy Ann*, F/V *Stephanie B II*, F/V *Regulus*, F/V *Carolina Boy* HABCAM : F/V *Kathy Marie* SMAST Drop Camera: F/V *Endeavor*, F/V *Guidance*, F/V *Karen Nicole*, F/V *Kathryn Marie*, F/V *Resolution*, F/V *Liberty*, F/V *Ranger*, F/V *Incentive*	Commercial and standardized NMFS scallop dredges, towed simultaneously.	NMFS New Bedford survey dredge: 8 ft width, 2 in rings, 4 in diamond twine top, and 1.5 in diamond mesh liner. Commercial gear: 15 ft Coonamessett Farm Turtle Deflector Dredge (CFTDD) with 4 in rings, 10 in diamond mesh twine top and no liner. Turtle chains are used in configurations as dictated by the area surveyed and current regulations. Tow speed: 3.8-4.0 kts Duration: 15 min	100 dredge tows in each rotational area when sampled using that method. Average number of dredge tows per year is about 200 in all areas.	Standard Avoidance and Move-on Rule
					Both a towed photographic and sonar hydroacoustic imaging system (HABCAM) and a drop camera and underwater video system is used to conduct the SMAST Video Survey Pyramid deployed from commercial scallop vessels.	HABCAM photographic system has 1 m field of view in each photograph, 5–10 frames per second with >50% overlap at 5 kts towing speed. Photo system coupled with two Imagenix side scan sonars or Teledyne Benthos C3D side scan sonars.	Between 350 and 690 nm of transects using digital photography by HABCAM each year. Drop camera typically samples over 400 stations on a 1.57 km sampling grid.	
NEFOP Observer Scallop Dredge Training Trips	This program provides certification training for NEFOP observers.	Maine to North Carolina	Annually, one-day trips throughout year as needed. 6 DAS	Contracted commercial fishing vessels	Contracted vessels scallop gear	Dredge type: Turtle Deflector Dredge Duration: 1 hr	2-3 tows per trip 12-18 tows total	All gear compliant with current commercial fishing regulations under the MSA. Continuous watch for marine mammals and sea turtles by vessel crew and NEFOP staff while underway and take action to avoid setting gear at times and places where concentrations of protected species are observed.
Sea Scallop Survey	The objective of this project is to determine distribution and abundance of sea scallops and collect related data for Ecosystem Management from concurrent stereo-optic images. It is conducted by the NEFSC.	North Carolina to GB	Summer, Annually 36 DAS	R/V *H. R. Sharp*	New Bedford type dredge	8 ft width, 2 in rings, 4 in diamond twine top, and 1.5 in diamond mesh liner. Tow speed: 3.8 kts Duration: 15 min at depth	225 dredge tows	Standard Avoidance and Move-on Rule.
					HabCam	2,500 lb towed metal frame 3 ft x 10 ft x 4 ft. Carries a payload of two digital cameras, 4 strobes, and two cylinders containing an array of oceanographic data towed with an electro-optic cable.	18 days of continuous stereo-optic camera towing	
Surfclam and Ocean Quahog Dredge Survey	The objective of this project is to determine distribution and abundance of Surfclam/ocean quahog and collect related data.	Southern Virginia to GB	One third of resource sampled per year over three year period. 15 DAS	Commercially contracted vessel (varies annually)	Hydraulic-jet dredge	12.5 ft cutting blade Tow speed: 1.5 kts Duration: 5 min at depth	150 tows	Minimal bottom time and construction of gear mitigate interactions with sea turtles

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Projects using other gears								
Beach Seine Survey, Maine	The project is a fish community survey at fixed locations.	Penobscot Bay and estuary, Maine	Annually, Apr.-Nov.	R/V *Silver Smolt*	45 m beach seine	5 mm nylon mesh	100 sets	Observe for marine mammals before and continuously during sampling. Net is not deployed if marine mammals are spotted. Scientists look as far as field of view permits from the beach in the general sampling area before the net is fished.
Beach Seine Survey, New Jersey	The project is a fish community survey at fixed locations.	Sandy Hook Bay and Navesink River, New Jersey	Summer	NA, conducted from shore	45 m beach seine	5 mm nylon mesh	90 sets	Observe for marine mammals before and continuously during sampling. Net is not deployed if marine mammals are spotted. Scientists look as far as field of view permits from the beach in the general sampling area before the net is fished.
Coastal Maine Telemetry Network	The objective of this project is to monitor tagged animals entering the Penobscot Bay System and exiting the system into the Gulf of Maine.	Penobscot River, estuary and bay, GOM	Deployed continuously year round in GOM and Apr.-Nov. in nearshore areas 10 DAS for data retrieval and maintenance.	Contract commercial Vessel	Fixed position acoustic telemetry array receivers on moorings spaced 250-400 m apart.	69 kHz receivers moored with buoys attached to 10 to 100 m lines	30 to 120 moorings, continuous in GOM, continuous from Apr.–Nov. in nearshore areas	Follow Take Reduction Plan gear restrictions for Penobscot Bay (i.e., sinking lines with 600 lb weak links on moored equipment).
Deep-sea Coral Survey	The objective of this program is to determine the species diversity, community composition, distribution and extent of deep sea coral and sponge habitats.	Continental shelf margin, slope, and submarine canyons and deep basins: GOM to Virginia	Annually, summer 16 DAS	R/V *H.B. Bigelow*	ROV (tethered)	Continuous and strobe lights, cameras, CTD, manipulator arm for sampling Speed: 3 kts Duration: 24 hr	10 dives	Standard Avoidance and Move-on Rule
					Towed Camera system	Strobe lights, camera, CTD Speed: 0.25 kt Duration: 8 hr	18 dives	
					CTD Profiler with Niskin 12-bottle rosette water sampler	Tow speed: 0 Duration: 1-5 hr	30 casts; 360 water samples (maximum)	
					ADCP	300 or 150 kHz	Continuous	
					Split beam and multi-beam acoustics	Output frequency: 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz	Intermittent	
Diving Operations	The objective of this project is to collect growth data on hard clams, oysters and bay scallops.	Long Island Sound	Year round 20 DAS	R/V *V. Loosanoff,* R/V *Milford 17,* R/V *Milford 22*	Wire mesh cages, lantern nets	1.5 in square wire mesh cages 60 in x 24 in x 18 in staked to the seabed	30 cages deployed for 1-36 months	Standard Avoidance and Move-on Rule
						Lantern nets 18 in diameter x 72 in long anchored to the seabed with 4 cinder blocks with the net oriented vertically	30 nets deployed for 1-36 months	
Ecology of Coastal Ocean Seascapes	This project is designed to provide information required for a next generation spatially and temporally explicit population simulation model for commercially important stocks such as summer flounder.	New York Bight	Annually, spring, summer, and fall 35 DAS	R/V *Nauvoo*, R/V *Resolute*	ADCP	600 kHz	80 tows	Standard Avoidance and Move-on Rule
					Hydroacoustic	120/38 kHz		
					Video sled	Sea Cam 5000 12v video cam towed at 1 kt for 300 m.		
					CTD	Sea Bird CTD		
					YSI	1.4 m x 1 m Tucker trawl		
					Plankton net	YSI 6000		

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Multi-nutrient analyzer	EcoLAB 2		
					Kemmerer bottle	2.2 L		
Ecosystem Monitoring ***(Replaced by expanded version in the Preferred Alternative, renamed "Northeast Integrated Pelagic Survey")***	This project assesses changing biological and physical properties including ichthyoplankton and zooplankton composition, abundance and distribution. Seabird / marine mammal observers survey birds, mammals, and sea turtles from the flying bridge on transits between stations during daylight hrs.	Cape Hatteras to Western Scotian Shelf	Quarterly 80 DAS	R/V *H.B. Bigelow*, R/V *Pisces*, R/V *G. Gunter*	Isaacs-Kidd midwater plankton trawl	Net size: 3 m Tow type: oblique Tow speed: 2.5 kts Duration: max 30 min	80 tows	Standard Avoidance and Move-on Rule
					Bongo net equipped with CTD	61 cm diameter Tow type: oblique Tow speed: 1.5 kts Duration: 20 min (max)	600 casts	
					Baby bongo: added to subset of Bongo tows	20 cm diameter, attached above standard Bongo	80 casts	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 1 hr (max)	250 casts	
					ADCP on vessel	300 kHz or 150 kHz	Continuous	
Estuarine Habitat Dynamics and Telemetered Movements ***(Survey not continued in the Preferred Alternative)***	The objective of this project is to establish an estuarine observatory for the tracking of acoustically tagged bluefish (adults and young-of-the-year), weakfish and striped bass in the Navesink River.	Shrewsbury and Navesink Rivers Sandy Hook Bay, New Jersey	Spring, summer, and fall 10 DAS	R/V *Nauvoo*, R/V *Harvey*	Acoustic tags and receivers	VR2 Vemco V8 Coded	N/A	Standard Avoidance and Move-on Rule
					Gill nets	50 ft x 8 ft gill net	4 sets	
Finfish Nursery Habitat Study	This project is designed to collect fish eggs, larvae, and juvenile fish from the seabed to identify essential habitats. The project tracks fish to determine habitat use.	Long Island Sound, New York	May-Oct. 10 DAS	R/V *V. Loosanoff*, R/V *Milford 17*, R/V *Milford 22*	Epibenthic Sled	1 m x 333 cm opening towed on the seabed Tow speed: 1.5 kts Duration: 5 min	20 tows	Standard Avoidance and Move-on Rule
					Bongo plankton net	Two 0.5 m diameter nets attached side by side towed at 0.5 kts at varying depths between the surface and bottom	20 tows	
					Neuston plankton net	1 m x 0.5 m opening towed at 1 kt at the surface	20 tows	
					Acoustic fish tags	70 kHz implanted tags	30 tags with 14-month life	
Gear Effects on Amphipod Tubes	The purpose of this project was to survey the abundance of amphipod tubes and examine the effects of bull raking and crab dredging.	Sandy Hook Bay, Barnegat Bay, and Great South Bay, New Jersey	Annually, July and Aug. 20 DAS Daytime sampling only.	R/V *Nauvoo*, R/V *Resolute*, R/V *Harvey*	Plankton net		Varies	Standard Avoidance and Move-on Rule
					YSI			
					Ponar sediment sampling grab (clam shell type)	Sample area: 152 mm x 152 mm Volume: 2.4 L		
Gulf of Maine Ocean Observing System Mooring Cruise	This project services oceanographic moorings operated by the University of Maine.	GOM and Northern GB	Spring 12 DAS	R/V *H.B. Bigelow*, R/V *Pisces*, R/V *G. Gunter*	ADCP on vessel	300 kHz	Continuous 600 km/year	Standard Avoidance and Move-on Rule
					ADCP on moorings	300 kHz, 75 kHz	Continuous	
Hydroacoustic Surveys	This project consists of mobile transects conducted throughout the estuary and bay to study fish biomass and distribution.	Penobscot Bay and estuary	25 DAS	R/V *Silver Smolt* or charter vessel	Split-beam and DIDSON	38 and 120 kHz split-beam 1.1 and 1.1 MHz DIDSON	Continuous 50 km per survey	Standard Avoidance

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Marine Estuaries Diadromous Survey	This project is a fish community survey at fixed locations.	Penobscot estuary and bay, Maine	Annually, Apr.–Nov. 100 DAS	R/V *Silver Smolt*	1 m and 2 m fyke nets	2 m fyke: 2 m x 2 m (1.9 cm main/0.6 cm mesh) 1 m fyke: 1 m x 1 m (0.6 cm mesh) Duration: 24 hr	100 sets	Nets deployed on low tide in intertidal areas, retrieved every 12 to 24 hours Mammal excluder on 2 m fyke net (14 cm gap opening) Small throat opening on 1 m fyke (12.7 cm round)
NEFOP Observer Gillnet Training Trips	This program provides certification training for NEFOP Observers.	Maine to North Carolina	Annually 10 DAS	Contracted commercial fishing vessels	Contracted vessels gillnet gear	String: 3-5 nets each Soak duration: 12-24 hr	4 sets per trip 40 sets total	Acoustic pingers used on all gillnet gear in compliance with commercial requirements. Continuous watch for marine mammals and sea turtles by vessel crew and NEFOP staff while underway and take action to avoid setting gear at times and places where concentrations of protected species are observed
Nutrients and Frontal Boundaries	The objective of this project is to characterize nutrient patterns associated with distinct water masses and their boundaries off of coastal New Jersey and Long Island in association with biological sampling.	MAB	Quarterly; Feb., May-June, Aug., and Nov. 10 DAS, sampling day and night	R/V *Resolute*	ADCP	600 kHz	Varies	Standard Avoidance and Move-on Rule
					Hydroacoustic	120/38 kHz		
					CTD	Sea Bird CTD		
Ocean Acidification	The objective of this project is to develop baseline pH measurements in the Hudson River water.	Hudson River Coastal waters	Quarterly 10 DAS, sampling day and night.	R/V *Resolute*	YSI	YSI 6000	Varies	Standard Avoidance and Move-on Rule
					Multi-nutrient analyzer	EcoLAB 2		
					Kemmerer bottle	2.2 L		
					CTD	Sea Bird CTD		
Pilot Studies	This program provides gear and platform testing.	Massachusetts state waters, GB	Annually, June 5 DAS Daylight	R/V *G Michelle*	AUV	Remus 100	4-8 hr missions	Standard Avoidance and Move-on Rule
Rotary Screw Trap (RSTs) Survey	This project is designed to collect abundance estimates of Migrating Atlantic salmon smolts and other anadromous species.	Estuaries on coastal Maine rivers	Apr. 15-June 15 60 sampling days	NA	Rotary Screw Trap	4 ft, 5 ft and 8 ft traps – aluminum construction, current propelled sampling devices.	Continuous (Apr.–June)	Daily tends of sampling device; adjustments in frequency if protected species likely to occur. If protected species are observed in the sampling area, sampling is suspended temporarily. If capture occurs, animal is temporarily retained in live tank and released as soon as possible.
Seabed Habitat Classification Survey	The objective of this project is to determine the composition of the surface layer of the seabed utilizing hydroacoustic equipment.	Long Island Sound	Year round 20 DAS Sampling occurs during daylight hours within two hours of high tide.	R/V *V. Loosanoff*, R/V *Milford 17*, R/V *Milford 22*	Quester Tangent seabed classification equipment	50/200 kHz transducer, Transducer fixed to hull operated at 4.5 kts	100 hr	Standard Avoidance and Move-on Rule
					Drop camera	24 in x 24 in x 24 in water filled box with a 12v DC video camera inside and two 60 watt 12v DC lights. Deployed 2 m or less from the seabed directly below the support vessel.	20 20-min sessions	
Trawling to Support Finfish Aquaculture Research	The objective of this project is to collect broodstock for laboratory spawning and rearing and experimental studies.	Long Island Sound	May through Aug. 30 DAS	R/V *V. Loosanoff*, R/V *Milford 17*, R/V *Milford 22*	Combination bottom trawl	Net size: 40 ft head rope, 40 ft sweep, 7 ft rise Tow speed: 2.5 kts Duration: 30 min	~50 tows to collect 100 adult scup	Standard Avoidance and Move-on Rule

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Shrimp trawl	Net size: 16 ft head rope, 16 ft foot rope, 2 ft rise Tow speed: 1.5 kts Duration: 30 min	~50 tows to collect 400 young-of-year scup	
					Rod and Reel	I/O circle and J hooks	12 hooks fished for ~100 hr to collect 50 adult black sea bass	
					Gill net	150 ft x 8 ft tied down gill net with 4 in stretch mesh, 24 hr sets	15 sets	
U.S. Army Corps of Engineers Bottom Sampling	This program provides habitat assessments monitoring.	Woods Hole, Massachusetts	Every two years 1 DAS	R/V *G Michelle*	Grab sampler	Peterson Grab	6 grabs	Standard Avoidance and Move-on Rule
SOUTHEAST US CONTINENTAL SHELF LME								
Projects using longline gear								
Apex Predators Bottom Longline Coastal Shark	The NEFSC conducts a bi-annual fishery-independent survey of Atlantic large and small coastal sharks in U.S. waters from Florida to Delaware to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration and age validation studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for other studies. The time-series of abundance indices (CPUE) from this survey is critical to the evaluation of coastal Atlantic shark species.	Florida to Rhode Island within 40 fathoms	Biannual, in spring 47 DAS	Charter Vessel	Florida style bottom longline	Mainline length: 4 mi Gangion length: 12 ft Gangion spacing: 60 ft Hook size and type: Mustad #349703 3/0 non stainless J hook Hooks per set: 300 Bait: spiny dogfish Soak time: 3 hr	71 sets (max.)	Move-on Rule. During the soak the line is run and if any sea turtles or marine mammals are sighted the line is pulled immediately. In addition, the Chief Scientist, at a minimum, is a NEFOP trained sampler and tagger for sea turtles for the NEFSC.
COASTSPAN Longline and Gillnet Surveys	This program determines location of shark nurseries, species composition, relative abundance, distribution, and migration patterns. Data are used to identify and refine essential fish habitat and provides standardized indices of abundance by species used in multiple species specific stock assessments. This component of COASTSPAN is conducted by cooperating institutions and agencies (South Carolina Department of Natural Resources [SCDNR], Georgia Department of Natural Resources [GDNR], and University of North Florida [UNF]).	Florida to Rhode Island.	Annually, summer. 85 DAS Daytime sets only	Cooperating institution and agency vessels	Bottom longline gear	Small juvenile gear / Large juvenile/adult shark gear Mainline length: 1000 ft / 1000 ft Gangion length: 5 ft / 8 ft Gangion spacing: 20 ft / 40 ft Hook size and type: 12/0 / 16/0 Mustad circle hooks Hooks per set: 50 / 25 Bait: finfish (mackerel or herring) Soak time: 30 min / 2 hr	SCDNR: 150 sets GDNR: 150 sets UNF: 150 sets	Move-on Rule.The gear is monitored during the soak; if any sea turtles or marine mammals are sighted during the soak and is considered to be at risk of interacting with the gear then the line is pulled immediately.
					Anchored sinking gillnet	325 ft x 10 ft Single panel of 4 in stretch mesh made of #177 (20 lb test) nylon monofilament 3 hr soak time while continuously running the net to tag and release targeted catch and release all bycatch	SCDNR: 20 sets UNF: 20 sets	

Table 2.3-1 Summary Description of the Additional Long-Term, NEFSC-Affiliated Surveys Considered under the Preferred Alternative.

These surveys and projects are in addition to those described under the Status Quo Alternative in Table 2.2-1. Units of measurement are presented in the format data was collected. Abbreviations used in the table: DAS = days at sea; m = meter; kts = knots; min = minutes; cm^2 = square centimeter; m^3 = cubic meter; kHz = kilohertz; ft = feet; in = inch; hr = hours; mi = miles.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
NORTHEAST US CONTINENTAL SHELF LME								
Projects using pelagictrawl gear								
Northeast Fisheries Observer Program (NEFOP) Mid-Water Trawl Training Trip	This program provides certification training for NEFOP Observers.	Maine to North Carolina	Annually 5 DAS	Contracted commercial fishing vessels	Various commercial nets	Varies by gear supplied by chartered vessel	1-2 tows per trip 5-10 tows total	Standard Avoidance and Move-on Rule. All NEFOP Observer protocols followed as per current NEFOP Observer Manual.
Northeast Integrated Pelagic Survey **(*Expanded and renamed version of Ecosystem Monitoring survey from Table 2.2-1*)**	The objective of this project is to assess the pelagic components of the ecosystem including water currents, water properties, phytoplankton, microzooolankton, mesozooplankton, pelagic fish and invertebrates, sea turtles, marine mammals, and sea birds.	Cape Hatteras to Western Scotian Shelf	Quarterly 80 DAS	R/V *H.B. Bigelow*, R/V *Pisces*, R/V *G. Gunter*	Hydroacoustic Midwater Rope Trawl	Net size: 15 m x 30 m Tow speed: 4 kts Duration: 5-30 min at depth	80 tows	Standard Avoidance and Move-on Rule. Seabird/marine mammal observers provide additional monitoring capacity as they survey birds, mammals, and sea turtles from the flying bridge on transits between stations during daylight hours.
					Isaacs-Kidd midwater trawl	3 m and 4.5 m Tow type: oblique Tow speed: 2.5 kts Duration: 30 min (max)	160 tows	
					Midwater trawl for use in shallow water (>15 m depth)	8 m x 8 m opening Tow speed: 2.5 kts Duration: max 30 min	80 tows	
					Split beam and multi-beam acoustics	Output Freq: 18 kHz, 38 kHz,70 kHz, 120 kHz and 200 kHz	Continuous	
					Bongo net equipped with CTD	61 cm diameter Tow type: oblique Tow speed: 1.5 kts Duration: max 20 min	600 tows	
					Baby bongo: added to subset of Bongo tows	20 cm diameter attached above standard Bongo	480 casts	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 1 hr (max)	250 casts	
					ADCP on vessel	300 kHz or 150 kHz	Continuous	
Projects using longline gear								
NEFOP Observer Bottom Longline Training Trips	This program provides certification training for NEFOP observers.	Maine to North Carolina	Annually 5 DAS	Contracted commercial fishing vessels	Commercial bottom longline gear	Mainline length: Approximately 3,000 ft Circle hooks: 600 per set	2-3 sets per trip 10-15 sets total	Standard Avoidance and Move-on Rule. All NEFOP Observer protocols followed as per current NEFOP Observer Manual. All applicable TRP gear requirements for commercial fisheries under the MSA.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Projects using other gears								
DelMarVa Habitat Characterization	The objective of this project is to characterize and determine key hard bottom habitats in coastal ocean off the DelMarVa Peninsula as an adjunct to the DelMarVa Reef Survey.	Coastal waters off DE, MD and VA	August, annual 5 DAS, daytime only	R/V *Resolute*	ADCP	600 kHz ADCP	Continuous	Standard Avoidance and Move-on Rule
					Single beam, dual frequency sonar	38 and 120 kHz, transects at 2-4 kts for 4-6 hrs.	20 transects	
					Video Sled	Sea Cam 5,000 12 volt video camera: tow speed 1 kt, 15 min transects (~500 m)	20 transects	
					CTD	Sea Bird CTD	20 casts	
					YSI	YSI 6000	20 drops	
					Plankton net	1.4 m x 1.0 m Tucker trawl	20 vertical tows	
					Ponar grab	152 m x 152 m	20 drops	
					Kemmerer bottle	2.2 L	20 casts: 20 water samples	
DelMarVa Reefs Survey	The objective of this project is determination of extent and distribution of rock outcrops and coral habitats and their use by black sea bass and other reef fishes	Coastal waters off DE, MD and VA	August, annual 5 DAS	R/V *Sharp*	HabCam towed camera vehicle	Still cameras w/strobe lighting, CTD, sidescan sonar (200 kHz) Towing speed: 5 kts	continuous	Standard Avoidance and Move-on Rule
					CTD Profiler	Tow speed: 0 Duration: 5-15 min	30 casts	
Miscellaneous Fish Collections and Experimental Survey Gear Trials	The James J. Howard Sandy Hook Marine Laboratory occasionally supports short-term research projects requiring small samples of fish for various purposes or to test alterations of survey gear. These small and sometimes opportunistic sampling efforts have used a variety of gear types other than those listed under Status Quo projects. The gears and effort levels listed here are representative of potential requests for future research support.	NY Bight Estuary waters	TBD	R/V *Nauvoo*, R/V *Resolute*, R/V *Harvey*, R/V *Chemist*	Combination bottom trawl	Net size: 23 ft head rope, 32 ft sweep, 7 ft rise Tow speed: 2.5 kts Duration: 20 min	5 trawls	Standard Avoidance and Move-on Rule
					Lobster pots	18 in x 24 in x 136 in wire pot Connected by 3/8 in rope With 7 in x 14 in surface float	1-60 pots set for 24-96 hr between retrievals	
					Fish pots	9 in x 9 in x 18 in wire pot With 1/8 in mesh liner Connected by 3/8 in rope With 7 in x 14 in surface float	1-60 pots set for 24-96 hr between retrievals	
					2 m beam trawl	1/4 in mesh liner, towed at 2 kts for 15 min	5 tows	
					Seine net	25-200 ft net	5 sets	
					Trammel nets	Multi Trammel Net, 12 in walling, 3 in^2 mesh 6 ft deep x 25 ft long	5 sets	
SOUTHEAST US CONTINENTAL SHELF LME								
Projects using other gears								
Opportunistic Hydrographic Sampling	This program consists of opportunistic plankton and hydrographic sampling during ship transit.	Southeast LME at depths less than 300 m	Early summer—once per year	R/V *Okenos Explorer*	Plankton net	2 m x 1 m net deployed to 25 m, 330 micron mesh	50 samples	Standard Avoidance and Move-on Rule
					Expendable bathythermographs	Sippican	50 deployments	

APPENDIX B

17.0 APPENDIX B - COOPERATIVE RESEARCH MATRIX

Table B-1 Cooperative Research Matrix 2008-2012

This table indicates the scope and type of short-term research projects conducted under status quo conditions in the recent past. The projects are organized by general purpose and gears used. All vessels used for these projects were commercial fishing vessels or chartered vessels capable of deploying the commercial fishing gears used in these types of projects.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
SURVEY PROJECTS						
Projects using trawl gear						
An industry-based survey for winter flounder in Southern New England	SNE, West of Closed Area (CA) I and north of Nantucket Lightship CA	5 survey cruises completed June-Oct. 2010	F/V *Seel*, F/V *Sasha Lee*, F/V *Sea Siren*, F/V *Iberia II*, F/V *United States*	Flat fish otter trawl	Bottom trawl. 60 ft head rope length x 80 ft ground rope length. Otter trawl survey net designed by Reider's Inc. 21 in rock hopper disks on sweep, tapered to 18 in and 16 in on wings, 20 fathoms bridle, 2-seam flat net using 4 mm Euro twine, 4.5 in mesh	288 tows at 20 to 30 min per tow
An industry-based survey for yellowtail flounder in Southern New England	SNE, Rhode Island Bight, Vineyard Sound, Long Island, NY	Aug.-Sept. 2011 (9 total trips were taken)	F/V *Heather Lynn*, F/V *Travis and Natalie*, F/V *Mary Elena*	Flat fish otter trawl	Bottom trawl. 360 x 6 in 2-seam flatfish otter trawl net, 3 in cookies, 135 ft sweep, 3 in codend mesh size	263 total tows at 20 to 30 min per tow
Cookie versus rock hopper sweep comparison	Paired trawl experiment: GOM, GB, SNE. Twin trawl experiment: SNE Fishing in 30 to 50 meter depth.	Twin trawl experiment: fall of 2009, 2 cruises lasting 5 days each, 10 DAS. Paired trawl experiment: fall of 2009, 6 cruises of 10 days each, 60 DAS	Twin trawl: F/V *Karen Elizabeth* Paired trawl: F/V *Endurance*, F/V *Moragh Kay*, F/V *Mary Kay*	Otter trawls with different sweeps (cookie and rock hopper)	Bottom trawl. Bigelow 4-seam 3-bridle net: two exact same nets with different sweeps (one cookie and one rock hopper)	Twin trawls: 100 tows, 20 min at 3 kts Paired tow experiment: 527 tows, 20 min at 3 kts

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using dredge gear						
Scallop survey transition and calibration tows from NMFS R/V ***Albatross*** **to the University of Delaware's** R/V ***Hugh R. Sharpe***	Entire range of Atlantic scallop resources, i.e., GOM, GB, SNE, MAB	Spring and fall survey periods, 2008	R/V *Albatross*, R/V *Hugh R. Sharpe*	Standard scallop survey dredge.	8 ft scallop dredge rigged with turtle chains, bag liner. Twin dredges towed simultaneously.	491 paired tows total.
Projects using hook and line gear						
Penobscot East bottom longline and jig fishing survey	GOM, up to 30 nm offshore between Vinehaven and Grand Manan Channel	July-Oct. 2013 and spring and fall 2014 pending funding, 20 DAS	F/V *Andanamra and* F/V *Tricia Clarke*	Longline and jig gear	Longline: 2000 hooks per set, ground line #7 with 1 fathom between hooks, #550 green gangion, #12 mustad semi-circle easy baiter hooks. Sets are soaked for 2 hr each. Jig: 80 pound power pro spectra with line on reel 40 pound braid. 3 hook setup (9/0 hook on bottom, 8/0 hooks on top and middle), 16-36 ounce diamond jig.	44 longline sets distributed among three depth strata, 88 total soak-hr 48 stratified random jigging stations, 5 lines per station, 5 min soak time.
Video hook-and-line survey to further knowledge of cusk (*Brosme brosme*) distribution and habitat preferences.	Statistical area 514 (western GOM, Old Scantum and New Scantum)	Aug.-Sept. 2011 and May-June 2012 (10 trips of approx. 4 hr)	F/V *Too Far*	Hook and line fishing gear and video equipment	Hook-and-line, drop camera (deep sea camera mounted on towed body)	10 trips, average of 4 rod-hours per trip
Projects using pot gear						
Application of broadband sonar technology for fisheries assessment and research	GOM – Coast wide in Maine waters	Year round sampling during 2009 commercial fishing season.	F/V *Jennifer and Emily*	Lobster boats equipped with acoustic sonar	Hydroacoustic sampling gear: Simrad ES70 single beam, dual-frequency systems.	Samples or numbers of lobster boat cruises not available

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Cooperative industry/university/government based scup and sea bass survey utilizing fixed gear	Scup: bays offshore MA and RI. Black sea bass: Four zones along East Coast (MA, RI, NJ, and VA).	Scup: 5 cycles, June 15-Oct. 15, 2010 Black sea bass: 16 locations sampled monthly Apr.-Oct. depending on the region. Southern sites sampled in the spring, northern sites in summer and fall.	F/V *Drake*, F/V *Evangeline*, F/V *Captain Robert*, others	Pot gear Black sea bass: 10 individual pots per set. 30 sets on random hard bottom areas.	Scup: unvented 2 ft x 2 ft x 2 ft pots constructed of 1.5 in mesh fished for 1-2 days. Black sea bass pots: 43.5 in x 23 in x 16 in pots constructed with 1.5 in coated wire mesh, fished for 1 day.	Scup: 30 pots at each of 15 sites every 4 weeks. Total 2700 pot hauls. Black sea bass: 30 pots at each of 16 sites sampled monthly. Total 3360 pot hauls.
CONSERVATION ENGINEERING PROJECTS						
Projects using trawl gear						
A method to reduce butterfish retention in the offshore *Loligo* squid fishery through the use of a bycatch reduction device (BRD) adapted to pre-existing gear.	SNE and MAB (Hudson Canyon region)	Nov.-Dec. 2010 and Jan.-Mar. 2011, 4 trips of 6-day durations.	F/V *Karen Elizabeth*	Otter trawl (twin trawl with experimental and standard squid nets).	Bottom trawl. Comparisons between the standard legal codend mesh size of 1 7/8 in to larger mesh sizes (2.5 in) test of economic viability and butterfish escapement.	1 hr tows, 7 tows per day. 84 tows total.
A method to reduce winter flounder retention through the use of avoidance gear; adaptations in the small mesh trawl fishery within the Southern New England/Mid-Atlantic winter flounder stock area	SNE and MAB	July 2010 10 DAS	Trawl vessel	Trawl gear	Bottom trawl. Side by side parallel tows, 1 fishing experimental and one fishing the regular commercial trawl.	1 hr tows at 3.2 kts, 4-6 tows per day, 40-60 paired tows total

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Collaborative network approach to reduce bycatch in the Southern New England/Mid-Atlantic squid trawl fishery (SQUIDNET)	SNE, MAB out to EEZ, Hudson Canyon and MAB	Fall 2010. Day and night sampling with 3 to 4 depth strata. 10-12 DAS	F/V *Karen Elizabeth*	Standard Bigelow net with acoustic equipment on net	Bottom trawl. 4-seam Bigelow net, Ecoview acoustic data to estimate density entering net or escapement, thus catchability. Same protocols as NEAMAP and Bigelow.	20 min tows. 40 day v. 40 night samples for comparisons.
Design and test of an innovative large mesh whiting trawl to reduce spiny dogfish bycatch in the Southern New England whiting fishery	SNE between Block Island and Nantucket Island	Aug.-Sept. 2010 10 DAS	Two whiting trawl vessels	Semi-pelagic trawl	Mid-water trawl. Side by side parallel tows, 1 fishing experimental and one fishing the regular commercial trawl.	1 hr tows at 3.2 kts, 4-6 paired tows per day, 40-60 paired tows total.
Design and test of a squid trawl with raised footrope rigging and a grid device to reduce winter flounder, scup and butterfish bycatch (SQUIDGRID)	Nantucket Sound (Statistical Block Numbers 99, 100, 101, 102, 115, 116)	June 1-Oct. 30, 2010 10 DAS per vessel	Two 70 ft squid trawlers	Experimental squid trawl	Bottom trawl. Paired tows with experimental and standard squid gear.	1 hr tows, 6 tows per day, 60 paired tows total.
Development and introduction of a low impact semi-pelagic (LISP) trawl.	Various areas, anticipated to occur in GOM, GB, and SNE	Two trips of 5-10 days each, trips may occur anytime during 2013.	F/V *Teresa Marie III*, F/V *Teresa Marie IV*, F/V *Harmony*, F/V *Nobska*, F/V *Morue*	2-seam otter trawl with 6 in mesh size, semi-pelagic doors.	Mid-water trawl. Netmind system to measure door spread and monitor door height off bottom, Gopro U/W camera to visually monitor doors and net.	2-4 hr tows, anticipated to complete 25 hauls per trip, 50 hauls total.
Eliminating flounder in the cod fishery with the use of a rigid escape vent behind the first bottom belly of the trawl.	Likely in SNE, Rhode Island Bight and GB	2013, 4 one-day trips	F/V *Lightening Bay*	Otter trawl	Bottom trawl. 360 ft x 60 ft 2-seam otter trawl with flounder escape vent and camera to observe fish response to gear.	1.5 hr tows, estimated 5 tows per day, 20 tows total.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Evaluation of a (modified) turtle excluder device (TED) design in the Southern New England and Mid-Atlantic summer flounder trawl fisheries	Coastal waters of SNE and MAB	June- Sept. 2008	Commercial trawl	Trawl	Bottom trawl. Experimental trawl with TED.	1.5 hr tows at 3 kts, 40 tows in SNE, 40 tows in MAB
Exploring bycatch reduction of summer, winter, yellowtail, and windowpane flounders using 12 in drop chain trawl net design in the small mesh fishery	Block Island Sound and Rhode Island Sound	May-Nov. 2010 12 DAS total	Two commercial trawlers	Bottom trawl	Side-by-side tow method comparing the control net with the experimental net, nets changed between vessels every 3 trips.	40 min tows, 4 to 5 tows per day, 48-60 paired tows total
Fishing efficiency and bottom contact effects of trawling with low-contact ground cables	GOM, Statistical Area 513	May–June 2013	F/V *Ellen Diane*, F/V *Sandi Lynn*	Demersal otter trawl	2-seam 6 in mesh, low contact ground cables. Tow speed approximately 2-3 kts.	Sample size unknown at this time.
Fuel saving in the topless trawl	GOM, Statistical area 514	May–June 2013	F/V *Mystic*	2-seam demersal otter trawl	6 in mesh size, head rope much longer than ground cable, topless configuration.	Sample size unknown at this time.
Groundfish net modified into topless flounder trawl	GOM, Statistical Area 133	May-June 2013	F/V *Stormy Weather*	Otter trawl modified to topless trawl	Standard 2-seam demersal trawl, 6 in trawl body and 6.5 in square mesh codend.	60 tows, 29-99 min at 2-3 kts
Reduce catch of white hake while targeting other groundfish species such as flounders in deep water habitat	GOM	May-June 2013	F/V *Jocka*	Demersal 2-seam otter trawl	6 in mesh, modified to topless trawl and rigged for deep water trials. Towed at 2-3 kts.	Sample size unknown at this time.
Reduction of butterfish and scup bycatch in the inshore *Loligo* squid fishery	Rhode Island Sound and Block Island Sound, Stat area 539	May-June and Sept.-Oct. 2009 10 DAS for each vessel	Two commercial bottom trawl vessels	Bottom trawl	Comparison of experimental and standard shrimp trawl gears	45-60 min tows at 3 kts, 120 tows total

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Rigid mesh belly escapement panel for SNE winter flounder in the small mesh *Loligo* trawl fishery	Off Long Island, New York	June–Oct. 2010, 16 trips	F/V *Rianda S*	Avoidance Gear Adaptations (AGA) otter trawl	Bottom trawl. Comparison of experimental and standard trawl gears	45 tows each for the control and experimental nets, 90 tows total.
Squid mesh study and field staff	Between Montauk, NY and Ocean City, MD at depths ranging between 60 m and 134 m	Sept.–Oct. 2008	F/V *Karen Elizabeth*	Twin otter trawl methods (demersal)	Comparison of experimental and standard trawl gears. High-opening *Loligo* nets, two-seam, two- bridle “rope trawls” with detachable codends (3.4 m diameter).	70 paired tows, 1 hr tows at 3 kts
Testing of new Reidar's haddock trawl on Georges Bank	GB	Likely June-Aug. 2013	F/V *Sao Paulo*	Demersal otter trawl	6 to 8 in mesh sizes	40 estimated tows, towed at 2-3 kts for 120 min
Testing of 6 in mesh-sized square and top belly on large mesh haddock trawl	GB, Statistical area 522	Year round but will be completed in June 2013, one 7-day trip	F/V *Sao Paulo*	Demersal otter trawl targeting haddock	6 in mesh size with large mesh panel in the top of the belly	As many tows as possible, 1 hr tows
Topless trawl in Southern New England and Mid-Atlantic summer flounder trawl fishery to reduce sea turtle interactions.	Panama City, FL, SNE, and MAB	June 15-Aug. 15, 2010 14 DAS, 7 on each vessel	Two commercial vessels	Topless trawl	Bottom trawl. Comparison of experimental topless trawl and standard trawl gear	90 min tows, 3 paired tows per day, 40 paired tows total.
Projects using dredge gear						
Testing of a sea scallop dredge designs: mesh size twine top for finfish bycatch reduction	GB Closed Areas I & II, SNE Nantucket Light Ship and Rhode Island Bight, Elephant Trunk Access Area, MAB DelMarVa Access Area	This has been an on-going research initiative since 2002. Most recent work done in 2009–2010. Most work was conducted Aug. 2009–Jan. 2010	F/V *Westport*, F/V *Kathy Ann*, F/V *Tradition*, F/V *Celtic*, F/V *Diligence*	Scallop dredge (modified turtle dredge, twin top, bag design) using various mesh sizes and graduation of mesh configurations and chain mat designs.	Standard New Bedford and modified turtle deflector scallop dredges (4-5 meters wide), using twine top mesh sizes ranging from 6–12 in and hung at ratios from 2:1 and with various numbers of meshes across the apron.	52-239 tows at 4- 4.5 kts per experiment. Total number of tows for project was 1675.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using hook and line gear						
Evaluating the practicality and economic viability of a pilot redfish jig fishery	Offshore banks in the GOM - Platts Bank and Jeffreys Bank	June-Aug. 2010 10 day-trips, 10 DAS total	Hook-and-Line vessel	Jig	3 jig lines from the vessel, 10 hr fishing time	30 line hr per trip, 300 line hr total
Projects using gillnets						
Application of up to three styles of gillnets to assess species selectivity and avoidance of low allocation species	GOM, Statistical area 513	June-July 2013, 4 trips	F/V *Karen Lynn*, F/V *Miss Maura*, F/V *Capt. Al*, F/V *Sweet Misery*	Sink gillnet	Three styles of nets: 2 ft raised footrope, 7 in mesh and 6.5 in mesh with larger twine. 100 ft long gillnet panels.	At least 12 sets each of three different gillnets
Bycatch Reduction Engineering Program (BREP) monkfish gillnet - sturgeon	New Jersey water in Statistical areas 612, 614 and 615	Nov.–Dec. 2010 and 2011	F/V *Dana Christine*, F/V *Traveller II*	Sink gillnet	Control nets: 12 meshes by 12 in mesh size with 48 in tie downs spaced 24 ft apart. Experimental nets: 6 meshes by 12 in mesh size with 48 in. tie downs spaced 12 ft apart. Gillnets configured in 10-panel strings totaling 3,000 ft long. Soak time: 96 hr or less.	120 total hauls with 60 replicates each year.
Projects using other gear						
Are Norwegian cod pots an effective and economically viable gear type for catching cod in New England?	GOM near Cape Cod, MA in statistical areas 537, 526, and 525	May-June 2013.	F/V *Illusion*, F/V *Rose Marie*, F/V *Heritage*, F/V *Evan Christine*, F/V *James and Matthew*	Norwegian cod pots in conjunction with standard commercial otter trawls.	Gear specifics not available at this time.	Sample size unknown at this time.
Reducing juvenile alewife, blueback, and American shad bycatch in the coastal poundnet and floating fish trap fisheries	GOM inshore waters - Bailey's Island	2009	Commercial vessels	Floating fish traps and pound nets	Large fish pound nets that are stationary. Catch is gathered up using large dip nets after pursing the pound net to concentrate the fish.	Sample size unknown at this time.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Sea turtle-scallop fishery interaction study	MAB and coastal waters off NJ and MD out to edge of shelf	Oct. 2011-Aug. 2012. Two research trips completed in 2011 (tagging) and follow-up cruise to conduct transects for turtle observing.	Commercial scallop dredgers, F/V *Kathy Ann*, F/V *Ms. Manya*, F/V *Celtic*	ROV equipped with underwater video, radio tagging of turtles	Ultra-Miniature Digital Scanning Sonar (model 852-000-100) designed by Imagenex Technology Corporation mounted on ROV and operated at a frequency of 675/850 kHz to scan a full 360° with a range of 150 mm up to 50 m. 10 Satellite Relay Data Loggers (SRDL) with Argos Fastloc GPS tags.	Transects run at 4 kts until turtles spotted. Then turtle following mode implemented with ROV.
TAGGING PROJECTS						
Projects using trawl gear						
Movement and migration patterns of winter flounder (*Pseudopleuronectes americanus*) tagged along the Maine coast	Throughout inshore waters from NH to Eastport, ME	Mid-Mar. and July 2011 32 DAS	Two commercial trawl vessels	Maine shrimp net	Mid-water trawl. 15- 20 min tows at 2.5 kts	Up to 10 tows made daily by each vessel, 650 total tows
Northeast cooperative research dogfish tagging program	GOM, GB, SNE	Feb. 2011 to Dec. 2012	F/V *Lisa Ann II*, F/V *Sao Paulo*, F/V *Heather Lynn*	Commercial otter trawl	Bottom trawl. 20 to 30 min tows	34,604 individual fish were tagged
Projects using hook and line gear						
Is Cape Cod a natural delineation for migratory patterns in U.S. and Canadian spiny dogfish stocks?	North and south of Cape Cod	3 periods in 2011, spring (early June), summer (Aug.), and Fall (Oct.).	Commercial longline and gillnet vessels	Longline and gillnet	Longline gear deployed for 30 min; Gillnets: 10 min sets	Longline: 5 sets per trip, 15 sets total Gillnets: 5 sets per trip, 15 sets total
Tagging - Halibut	Coastal waters of Maine (2-24 nm offshore)	May–July 2007 and 2008	Commercial vessels	Longline gear	1800 ft of ground line with 3 ft gangions, 300 hooks per set. Circles hooks of numbers and (sizes): 33 (12/0), 33 (14/0) and 34 (16/0) were randomly assigned on a center point.	51 stations. Soak time was between 5 and 24 hr.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using gillnets						
Tagging to assess monkfish (*Lophius americanus*) movements and stock structure in the Northeastern U.S. and age validation of monkfish in the Gulf of Maine	GOM, SNE and MAB (two sample sites each in Southern and Northern Management Areas)	Sept. 2007 to Jan. 2008, 18 separate DAS	F/V *C.W. Griswold,* F/V *Gertrude H.*	Commercial gillnets	8 to 12 in mesh gillnets, soak times ranged from 2-5 days	Sample size unknown at this time.
LIFE HISTORY PROJECTS						
Projects using trawl gear						
Defining Atlantic wolffish aggregations in Massachusetts Bay	Massachusetts Bay, Stellwagen Bank National Marine Sanctuary Stat area 514	May 22-June 30, 2011 10 DAS	Trawl vessels	Bottom trawl.	<30 min tows at 2.8 kts	5 tows per day, 50 tows total
Synoptic acoustic and trawl surveys to characterize biomass and distribution of the spring spawning aggregations of Atlantic cod in Ipswich Bay	Ipswich Bay, Statistical area 133	Single nights: late March, mid-May, mid-June, and mid-July of 2011; 8 DAS total	Two bottom trawlers	Bottom trawl and echosounder	10 min tows at 2 kts	10 pre-planned, and 5 adaptive tows per vessel per day, 4 days towing each, 120 tows total
Temporal aspects of habitat utilization and interspecies competition: defining the ecological impacts of spiny dogfish in structuring ecosystem dynamics of Southern New England	Off the coast of Rhode Island (Block Island)	May-Aug. 2009, 1 day per month	Commercial trawlers F/V *Proud Mary,* F/V *Elizabeth Helen*	Bottom trawl, midwater trawl	30 min tows for vessel at 2.5 –3 kts. Codend 15.2 cm mesh – 5.1 cm liner, sweep 23.7 m, spread 10.7 m.	5 tows each per day, 50 tows total

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using pot gear						
Examining settlement dynamics of postlarval American lobster, (*Homarus americanus*), in Lobster Management Area 2	Buzzards Bay, Rhode Island Sound, and Narragansett Bay (Statistical areas 538, 537, and 539)	May-Oct. 2009	Lobster vessels	Settlement collectors, satellite drifters	Settlement collectors will be deployed for about 90 days.	Varies
Expansion of the coastwide ventless lobster trap survey in Southern New England	Buzzards Bay, Rhode Island Bight, Block Island Sound, Long Island Sound.	June-Sept. 2010	F/V *Sherri & Deke*, F/V *Aaron Cebula*, F/V *Andrea C*, F/V *Jarrett Drake*, F/V *Cynthia Lee*	Standardized lobster pots	Alternating vented /ventless lobster pots, 21 in x 40 in x 14 in. 3-5 days soak time.	2 hauls per month, 8 hauls total
Exploratory fixed gear survey in the inshore Gulf of Maine, utilizing trap gear and targeting Atlantic wolffish	GOM, focusing on Boothbay Harbor, ME	Mid-Apr. to mid-June 2010, 2011, and 2012 6 DAS	Commercial lobster boat	Lobster pots with modified trap gear	Soak time depends on results	10 pots per sample, sample once per week
The Buzzards Bay lobster resource: are changes in reproduction having a negative impact on the fishery?	Buzzards Bay, MA, Lobster Management Area 2, Statistical area 538.	30 days in June-July, and one week in Nov. 2009 and 2010 6 DAS total	Lobster vessels	Lobster pots	24 to 48 hr soaks, pots set in June, retrieved in July, re-set in Nov., retrieved the end of Nov.	Total of 120 traps, 20 trawls (strings) grouped in 4 locations, 5 trawls per location, total of 40 vertical buoy lines
The use of settlement collectors to investigate the early life history of Atlantic wolffish (*Anarhichas lupus*) and Cusk (*Brosme brosme*) in the Gulf of Maine	Closed Area on Jeffery's Ledge	Nov. 2012-Aug. 2013, 8 trips total	F/V *Lady Victoria*	Lobster pots filled with cobble.	60 cm x 91 cm x 15 cm pots	32 pots total, 3-4 per month

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using other gear						
A fisherman-scientist collaboration to re-assess lobster nurseries in Narragansett Bay after two decades of environmental change	Narragansett Bay, Rhode Island	July 1, 2011–June 30, 2013	Commercial vessel. Also, cobble-filled collectors deployed by lobstermen.	Scuba divers and cobble collectors	Scuba divers using visual and suction sampling of 1 m^2 sampling units at 5 m and 10 m deep. Lobstermen place cobble collectors (2 ft x 4 ft mesh baskets filled with cobble)	20 quadrats per site, 4-5 sites per day. Visual counts and suction sampling at all sites.
An assessment of quahog larval supply and distribution in the Upper Narragansett Bay with a focus on spawning sanctuaries and alternative area management strategies	Narragansett Bay, Rhode Island	Sept.-June 2011-2013 (on-going - no final report	Not available	Not available	Not available	Sample size unknown at this time.
Studying the population of the channeled whelk (*Busycotypus canaliculatus*) fishery	Nantucket Sound, Vineyard Sound	June 2011-Oct. 2012 – varies but mostly during summer	Commercial vessels	Standard commercial whelk traps	Traps and bait used are variable. Typically about 22 in x 22 in x 10 in with 12 in x 12 in openings, weighted down with concrete blocks and deployed in strings of up to 10 pots.	Sample at least 200 individual animals
HABITAT PROJECTS						
Projects using other gear						
High resolution video survey of the sea scallop resource, recruitment patterns and habitat of Closed Areas relative to scallop and groundfish management	GB- Closed Area	2013	Commercial scallop vessel	Drop camera, towed vehicle coupled with dredge sampling	Commercial scallop dredge	Sample size unknown at this time.

2.3.2 Short-term Research Activities

Table 2.3-2 Collective Scope of Short-Term, Cooperative Research Activities Considered under the Preferred Alternative.

Gear Used	General Area of Operation	Season	Number of Samples
SURVEY PROJECTS			
Trawls • Flatfish Surveys • Monkfish, longfin squid and other catchability surveys	GOM, GB, SNE, MAB	Year round but primarily Summer-Fall	Flatfish surveys: 550 bottom tows per year, 20-30 min/tow at 3 kts Monkfish and catchability surveys: 630 pelagic tows per year, 20-30 min/tow at 3 kts
Hook and Line • Eastern Maine hook and line/ jig survey in hard bottom areas • Western-Central Gulf of Maine hard bottom longline survey	Downeast Maine coastal waters, western-central GOM, coastal waters and off-shore waters focused on sea mounts.	Spring and Fall	60 longline stations per year in eastern Maine, 90 longline stations per year in western-central GOM, up to 2,000 hooks per station depending on tide 48 stratified random jigging stations in eastern Maine, 5 lines per station, 3 hooks per line, 5 min soak time
Pots/traps • Scup & black sea bass pot survey	SNE, Rhode Island Bight, Nantucket Sound, MAB waters from shore to shelf edge.	Spring and fall for black sea bass. Year round for scup.	Scup/ black sea bass: 2,650 pot sets per year
CONSERVATION ENGINEERING PROJECTS			
Bottom Trawl • Gearnet conservation engineering work • Selectivity studies in Acadian redfish fishery and other Small mesh fisheries • Squid selectivity studies	GOM, GB, SNE, MAB	Year round sampling in various studies.	Estimated 500 tows per year under various protocols similar to commercial fishing conditions. Assume tow durations average 60 min per tow.
Dredge • Scallop dredge finfish and turtle excluder research • Hydrodynamic dredge development	GB, SNE, MAB	Annually Aug.-Jan.	Estimated over 1,700 dredge tows per year.
Hook and Line • Utilization of electric rod and reel jig fishing targeting groundfish in the Gulf of Maine	Western GOM	Oct.-Jan.	20 DAS total, two vessels with 4 jigging machines (electric reels) each.

Gear Used	General Area of Operation	Season	Number of Samples
Gillnets • Gillnet pinger exchange and research • Raised foot rope gillnet selectivity study	GOM and GB Gillnet raised foot rope-Statistical area 513	Pinger exchange summer 2013, fishing year around. Raised foot-rope gillnet fishing monthly.	Raised foot rope: 69 sets of 24 hr soak time duration. 100 ft long nets, 4-net sets. Pinger-details not available.
Pots/traps • Efficient cod harvesting using fish pots as an adjunct to otter trawl trips (TRAWLPOT)	Statistical areas: 525, 526, 537 (near CA1, western side of Great South Channel, and Block Island area)	5 sample periods, ideally in Spring	Newfoundland cod pots (2 m x 2 m x 1 m), 10 pots deployed at a time, 2-5 days soak, 100-250 pot soak days total
TAGGING PROJECTS			
Trawl • Winter flounder migration patterns	Coastal waters in Gulf of Maine from New Hampshire to Stonington/Mt. Desert Island, Maine	Spring and Summer	10 otter trawl tows daily, up to 650 bottom trawls per year, 15-20 min per tow at 2.5 kts
Hook & Line and Gillnet • Spiny dogfish tagging north and south of Cape Cod • Cusk & NE multi-species tagging	GOM and GB waters adjacent to Cape Cod, MA	Spring, Summer, Fall sampling periods	Long line: 5 sets per trip, 15 sets total. Gillnet: 5 sets per trip, 15 sets total. (10 min sets)
Gillnets • Monkfish tagging	GOM, SNE, MAB	Sept.–Jan.	18-20 DAS, 10 short-duration sets per day, 180-200 sets total
LIFE HISTORY PROJECTS			
Gillnets • Monkfish population dynamics and climate change	MAB (work conducted by University of MD Eastern Shore under Research Set Aside Program)	Spring through Summer	Collecting fishery dependent data from monkfish collaborators. Number of gillnet sets dependent on commercial fishing operations, unknown at present.
HABITAT PROJECTS			
Pots/traps (artificial substrate settlement studies) • Lobster settlement research • Wolffish and cusk habitat studies	SNE, Rhode Island Bight Western GOM, Jeffery's Ledge Closed Area	Spring, Summer Fall All months	Total of 120 traps, 20 trawls (strings) grouped in 4 locations, 5 trawls per location, total of 40 vertical buoy lines. 32 pot sets, 3-4 per month.

APPENDIX C

Sea turtle handling and resuscitation measures as found at 50 CFR 223.206(d)(1).

(d) (1) (i) Any specimen taken incidentally during the course of fishing or scientific research activities must be handled with due care to prevent injury to live specimens, observed for activity, and returned to the water according to the following procedures.

(A) Sea turtles that are actively moving or determined to be dead as described in (d)(1)(i)(C) of this section must be released over the stern of the boat. In addition, they must be released only when fishing or scientific collection gear is not in use, when the engine gears are in neutral position, and in areas where they are unlikely to be recaptured or injured by vessels.

(B) Resuscitation must be attempted on sea turtles that are comatose, or inactive, as determined in paragraph (d)(1) of this section by:

(1) placing the turtle on its bottom shell (plastron) so that the turtle is right side up, and elevating its hindquarters at least 6 inches (15.2 cm) for a period of 4 up to 24 hours. The amount of the elevation depends on the size of the turtle; greater elevations are needed for larger turtles. Periodically, rock the turtle gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about 3 inches (7.6 cm) then alternate to the other side. Gently touch the eye and pinch the tail (reflex test) periodically to see if there is a response.

(2) sea turtles being resuscitated must be shaded and kept damp or moist but under no circumstance be placed into a container holding water. A water-soaked towel placed over the head, neck, and flippers is the most effective method in keeping a turtle moist.

(3) sea turtles that revive and become active must be released over the stern of the boat only when fishing or scientific collection gear is not in use, when the engine gears are in neutral position, and in areas where they are unlikely to be recaptured or injured by vessels. Sea turtles that fail to respond to the reflex test or fail to move within 4 hours (up to 24, if possible) must be returned to the water in the same manner as that for actively moving turtles.

© A turtle is determined to be dead if the muscles are stiff (rigor mortis) and/or the flesh has begun to rot; otherwise the turtle is determined to be comatose or inactive and resuscitation attempts are necessary.

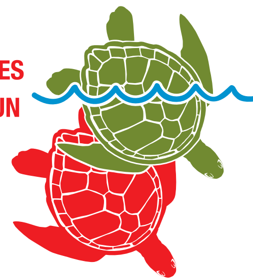
SEA TURTLE HANDLING AND RESUSCITATION REQUIREMENTS

IF YOU ENCOUNTER AN ENTANGLED, INJURED OR UNRESPONSIVE SEA TURTLE,
please immediately call the National Marine Fisheries Service Northeast Region Hotline:

866-755-NOAA (6622)

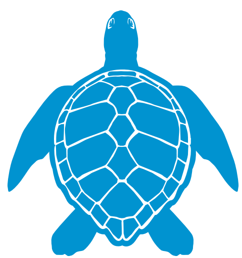
Any sea turtle taken incidentally during fishing must be handled with care to prevent injury, observed for activity, and returned to the water according to the following procedures:

(A) A SEA TURTLE THAT IS ACTIVELY MOVING OR IS DEAD (THAT IS, IF MUSCLES ARE STIFF AND/OR THE FLESH HAS BEGUN TO ROT) MUST BE RELEASED OVER THE VESSEL'S STERN ONLY:



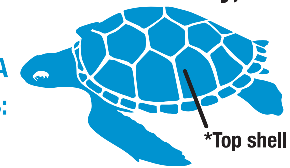
- When fishing gear is not in use,
- When the engine is in neutral, and
- In areas where the turtle is unlikely to be recaptured or injured by vessels.

OTHERWISE, YOU MUST CONSIDER THE TURTLE UNRESPONSIVE AND ATTEMPT RESUSCITATION AS DESCRIBED IN (B).



You are strongly encouraged to read the full regulation, which can be found at 50 CFR 223.206(d)(1).

(B) YOU MUST ATTEMPT RESUSCITATION ON SEA TURTLES THAT ARE UNRESPONSIVE AS FOLLOWS:



(1) Place the turtle top shell up* and elevate its hindquarters at least 6” (or 15-30°) for at least 4 hours and up to 24 hours.

- The amount of elevation depends on the turtle's size; larger turtles require greater elevation.
- In warm weather (over 60 °F), keep the turtle shaded and moist, preferably by placing a damp towel over the head, shell, and flippers. You must NOT place the turtle into a container of water.

(2) Periodically rock the turtle gently side to side by holding the outer edge of the shell and lifting one side about 3”, then alternate to the other side.

(3) Periodically gently touch the eye and pinch the tail (reflex tests) to see if there is a response.

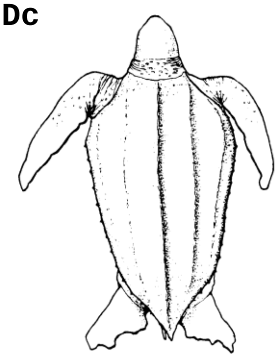
(C) IF THE TURTLE REVIVES AND BECOMES ACTIVE DURING RESUSCITATION EFFORTS, you must release it over the vessel's stern as described in (A). If the turtle does not respond to the reflex test (as described in (B) (3)) or move within 4 hours (up to 24 hours, if possible), you must return the turtle to the water in the same manner.

APPENDIX D

Identification Key for Sea Turtles and Sturgeon Found in Northeast U.S. Waters

SEA TURTLES

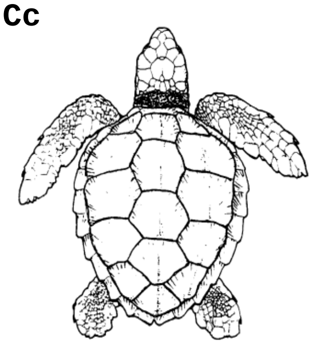
Dc



Leatherback (*Dermocheyls coriacea*)

Found in open water throughout the Northeast from spring through fall. Leathery shell with 5-7 ridges along the back. Largest sea turtle (4-6 feet). Dark green to black; may have white spots on flippers and underside.

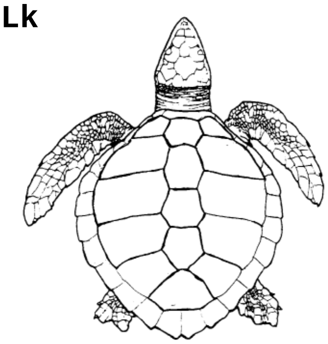
Cc



Loggerhead (*Caretta caretta*)

Bony shell, reddish-brown in color. Mid-sized sea turtle (2-4 feet). Commonly seen from Cape Cod to Hatteras from spring through fall, especially in southern portion of range. Head large in relation to body.

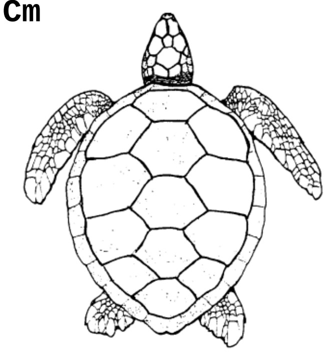
Lk



Kemp's ridley (*Lepidochelys kempi*)

Most often found in Bays and coastal waters from Cape Cod to Hatteras from summer through fall. Offshore occurrence undetermined. Bony shell, olive green to grey in color. Smallest sea turtle in Northeast (9-24 inches). Width equal to or greater than length.

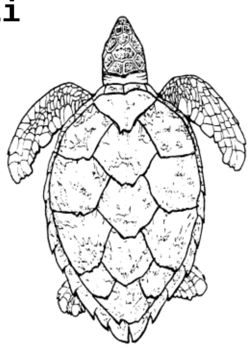
Cm



Green turtle (*Chelonia mydas*)

Uncommon in the Northeast. Occur in Bays and coastal waters from Cape Cod to Hatteras in summer. Bony shell, variably colored; usually dark brown with lighter stripes and spots. Small to mid-sized sea turtle (1-3 feet). Head small in comparison to body size.

Ei

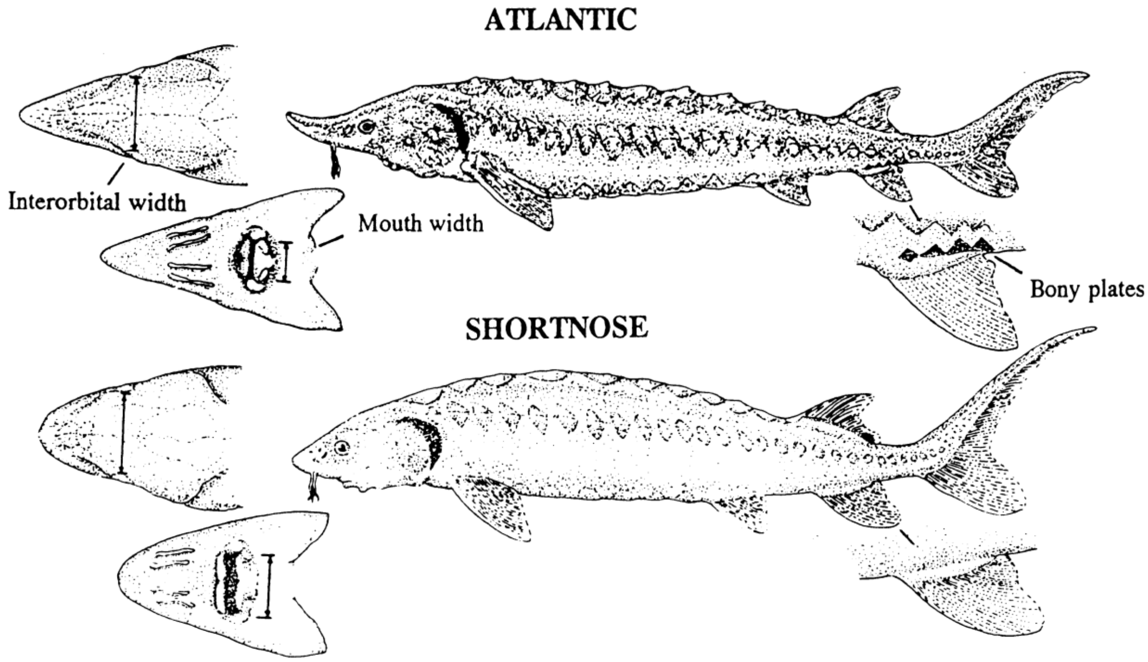


Hawksbill (*Eretmochelys 6mbricate*)

Rarely seen in Northeast. Elongate bony shell with overlapping scales. Color variable, usually dark brown with yellow streaks and spots (tortoise-shell). Small to mid-sized sea turtle (1-3 feet). Head relatively small, neck long.

APPENDIX D, continued

SHORTNOSE AND ATLANTIC STURGEON



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

Characteristic	**Atlantic Sturgeon, *Acipenser oxyrinchus***	**Shortnose Sturgeon, *Acipenser brevirostrum***
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004

APPENDIX E

Procedure for Biosampling Sturgeon and Salmon for Genetic Analyses

Fin clip fixed in 95% non-denatured ethanol: Due to the rate of ethanol evaporation, only vials with lids that are intended to prevent evaporation should be used (e.g., vial with a ring-sealed, screw on lid). Note: in place of 95% non-denatured ethanol, sea water may be used as well.

1. Using a knife, scalpel, or scissors that has been thoroughly cleaned and wiped with alcohol, cut a one-cm square piece of tissue from the tip of the pelvic fin.
2. Using one vial per fish, place the fin clip into a vial that contains 95% non-denatured ethanol and closes with a screw on, ring-sealed cap. Put parafilm around each cap to minimize the chance of evaporation or leaking. Label the vial with the date and name of project under which the sturgeon take occurred.
3. If possible, the vial should be refrigerated or placed on ice so that it remains chilled for the first 24 to 48 hours. Otherwise, vials can be stored at room temperature.

Shipping Biosamples

Vials containing the fin clip samples should be packed for shipment in a manner that minimizes the chance of breakage and leakage and shipped in accordance with NMFS Guidelines for Air-Shipment of "Excepted Quantities" of Ethanol Solutions.

All samples should be sent to:

Dr. Tim King
U.S. Geological Survey
Leetown Science Center
Aquatic Ecology Branch
11649 Leetown Road
Kearneysville, West Virginia 25430
(Phone: 304.724.4450)

Prior to sending genetic samples, we suggest that you email Dr. Tim King (tlking@usgs.gov), copying his technician (Barb Lubinski at blubinski@usgs.gov), providing the number of samples to be shipped, the anticipated shipping date, and the shipping carrier. For example, "On (date), NOAA Fisheries, Ecosystem Surveys Branch anticipates shipping to your lab via (carrier) a package containing (#) sturgeon genetic samples fixed in ethanol that were collected in accordance with the Terms and Conditions of the 2016 NEFSC Programmatic BiOp.

APPENDIX F

Add in thumbnail(s) of PSIT database entry

PSIT Map Tool | User Guide | sarah.pike@noaa.gov | Last Logon: 2016-02-18 10:51 | Logout

PS ch | PS ort | PS rd | PS lap

NEFSC

Add Survey

Verify Location

0 0

0 0

Search Reset

Save New

24 hr Notice Report of Protected Species

ORGANISM ID: 29225

Species Name: Acipenser oxyrinchus (Atlantic sturgeon)

Organism Actions | Parameter

ORGANISM PARAMETER VALUES

Go Actions

Record Weight	Weight	31	kg
Record Sturgeon T-Bar Tag No.	Record Tag Number	43837	-
Inside Mouth Width	Width	48	mm
Outside Mouth Width	Width	77	mm
Underside Head Width Inline With Mouth	Width	143	mm
Interocular (Between Eye) Width	Width	134	mm
Sturgeon Pit Tag Status	No Pit Tag Found/New Pit Tag Inserted	Yes	-
Record Sturgeon Pit Tag Number	Record Tag Number	985161000838270	-
Protected Species Condition at Capture	Alive Uninjured	Yes	-
Protected Species Condition at Release	Alive Uninjured	Yes	-

Preserve Sturgeon Pelvic Fin Tissue	Barcode	ECFE2620A9B145FE	-
Fork Length	-	-	-
Unexpected Species	-	-	-
Sturgeon Freeze Rule	-	-	-

Comments: tail cut short - total length up to stump; photos lateral view 011.jpg; dorsal to caudal 013.jpg; animal released in good condition

Organism Actions	Parameter

Save Comments

Hide Buttons

PHOTOGRAPHS AND ADDITIONAL DATA

Name		Parameter
Sturgeon Photos	Anal Fin To Caudal Fin	Yes
Sturgeon Photos	Dorsal Fin To Caudal Fin	Yes
Sturgeon Photos	Ventral Head View With Ruler	-
Sturgeon Photos	Inside Mouth Width With Calipers	Yes
Sturgeon Photos	Lateral View With Measuring Tape	Yes
Sturgeon Photos	Outside Mouth Width With Calipers	-

1 - 6

CRUISE

Vessel	Mission	Cruise

1 - 1

CAPTURE DATA

Capture lat	Capture lon	Release lat

Organism Actions	Parameter

- -

APPENDIX G

Incident Report: ESA Listed Species Take

Photographs should be taken and the following information should be collected from all listed fish and sea turtles (alive and dead) collected.

Observer's full name:____
Reporter's full name:____

Species Identification:______________________________________

Type of Gear and Length of deployment:
____
____

Date animal observed:_______________ Time animal observed: ______________________
Date animal collected:_______________ Time animal collected:_______________________

Environmental conditions at time of observation (i.e., tidal stage, weather):
____
____

Water temperature (°C) at site and time of observation:_______________________
Describe location of animal and how it was documented (i.e., observer on boat):
____

Sturgeon Information:
Species _________________________________

Fork length (or total length) ____________________ Weight ______________________

Condition of specimen/description of animal
____
____
____
____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish tagged: YES / NO *Please record all tag numbers.* Tag # ________________

Photograph taken: YES / NO
(please label *species, date, geographic site* and *vessel name* when transmitting photo)

Genetics Sample taken: YES / NO
Genetics sample transmitted to: ____________________ on ____/_____/2012

APPENDIX G, continued

Sea Turtle Species Information: *(please designate cm/m or inches.)*

Species ______________________________ Weight (kg or lbs)____________________________

Sex (circle): Male Female Unknown How was sex determined? ___________________

Straight carapace length ________________ Straight carapace width _____________________

Curved carapace length ________________ Curved carapace width ______________________

Plastron length _______________________ Plastron width ______________________________

Tail length ____________________________ Head width _______________________________

Condition of specimen/description of animal____

____

Existing Flipper Tag Information

Left ______________________________ Right __________________________________

PIT Tag # __________________________________

Miscellaneous:

Genetic biopsy taken: YES NO

Photos Taken: YES NO Is this a Recapture: YES NO

Turtle Release Information:

Date ___________________________ Time _______________________________

Lat ____________________________ Long _______________________________

State ___________________________ County _____________________________

Remarks: (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propeller damage, papillomas, old tag locations, etc.)

____

____

APPENDIX H

STURGEON SALVAGE FORM

For use in documenting dead sturgeon in the wild under ESA permit no. 17273 (version 7-24-2015)

INVESTIGATORS'S CONTACT INFORMATION
Name: First ________________ Last ________________________
Agency Affiliation ________________ Email______________________
Address ____
____
Area code/Phone number ____________________________________

UNIQUE IDENTIFIER (Assigned by NMFS)

DATE REPORTED:
Month ☐☐ Day☐☐ Year 20☐☐
DATE EXAMINED:
Month ☐☐ Day☐☐ Year 20☐☐

SPECIES: (check one)
☐ shortnose sturgeon
☐ Atlantic sturgeon
☐ Unidentified *Acipenser* species
Check "Unidentified" if uncertain .
See reverse side of this form for aid in identification.

LOCATION FOUND: ☐Offshore (Atlantic or Gulf beach) ☐Inshore (bay, river, sound, inlet, etc)
River/Body of Water________________ City________________________ State ____
Descriptive location (be specific)____
____
____
Latitude ______________N (Dec. Degrees) Longitude ______________ W (Dec. Degrees)

CARCASS CONDITION at time examined: (check one)
☐ 1 = Fresh dead
☐ 2 = Moderately decomposed
☐ 3 = Severely decomposed
☐ 4 = Dried carcass
☐ 5 = Skeletal, scutes & cartilage

SEX:
☐ Undetermined
☐ Female ☐ Male
How was sex determined?
☐ Necropsy
☐ Eggs/milt present when pressed
☐ Borescope

MEASUREMENTS: Circle unit
Fork length ________ cm / in
Total length ________ cm / in
Length ☐ actual ☐ estimate
Mouth width (inside lips, see reverse side) ________ cm / in
Interorbital width (see reverse side) ________ cm / in
Weight ☐ actual ☐ estimate ________ kg / lb

TAGS PRESENT? Examined for external tags including fin clips? ☐ Yes ☐ No Scanned for PIT tags? ☐ Yes ☐ No

Tag #	Tag Type	Location of tag on carcass

CARCASS DISPOSITION: (check one or more)
☐1 = Left where found
☐2 = Buried
☐3 = Collected for necropsy/salvage
☐4 = Frozen for later examination
☐5 = Other (describe) ________________________

Carcass Necropsied?
☐Yes ☐No
Date Necropsied:____________
Necropsy Lead:
____

PHOTODOCUMENTATION:
Photos/vide taken? ☐ Yes ☐ No
Disposition of Photos/Video:__________
____
____

SAMPLES COLLECTED? ☐ Yes ☐ No

Sample	How preserved	Disposition (person, affiliation, use)

Comments:
____
____
____

Distinguishing Characteristics of Atlantic and Shortnose Sturgeon (version 7-24-2015)

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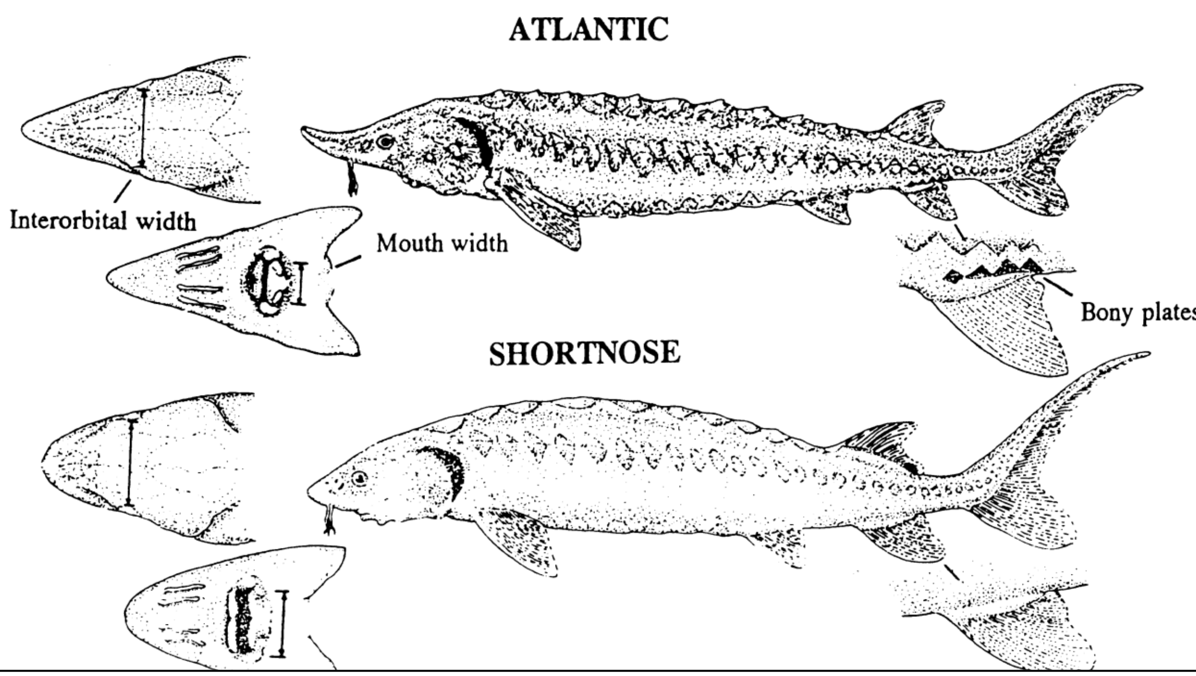
* From Vecsei and Peterson, 2004



Describe any wounds / abnormalities (note tar or oil, gear or debris entanglement, propeller damage, etc.). Please note if no wounds / abnormalities are found.

____

____

____

____

____

Data Access Policy: Upon written request, information submitted to National Marine Fisheries Service (NOAA Fisheries) on this form will be released to the requestor provided that the requestor credit the collector of the information and NOAA Fisheries. NOAA Fisheries will notify the collector that these data have been requested and the intent of their use.

Submit completed forms (within 30 days of date of investigation) to: **Greater Atlantic Regional Fisheries Office Contacts** – Edith Carson (Edith.Carson@noaa.gov , 978-282-8490) or Lynn Lankshear (Lynn.Lankshear@noaa.gov, 978-282-8473); **Southeast Region Contact**- Stephania Bolden (Stephania.Bolden@noaa.gov, 727-551-5768).