NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Environmental Protection Agency (EPA), Region I

Activity Considered: Re-Initiation of Formal ESA Section 7 Consultation for the Kennebec River Fish Assemblage Study

NER-2014-11398

Conducted by: National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office

Date Issued: 2015 JAN 12

Approved by: for John Bullard

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1.0 INTRODUCTION AND BACKGROUND

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) on the effects of the U.S. Environmental Protection Agency's (EPA) continued funding of a multi-year bio-assessment study on the Kennebec and Sebasticook Rivers in accordance with section 7 of the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 *et seq.*). EPA provides funds to the Midwest Biodiversity Institute (MBI) for the conduct of an electrofishing survey in the lower Kennebec River and Sebasticook River in Maine. The purpose of the survey is to document changes to fish assemblages in the rivers following the removal of the Edwards Dam in 2001 and the Ft. Halifax dam in 2009. All proposed sample sites occur within the geographic range of the listed Gulf of Maine (GOM) Distinct Population Segment (DPS) of Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon from the GOM DPS, and/or, the New York Bight (NYB) DPS. The Kennebec River sampling sites also occur within designated critical habitat for the GOM DPS of Atlantic salmon.

We issued a Biological Opinion on the effects of these surveys to be carried out annually from 2013-2017 on September 23, 2013. This Opinion concludes reinitiation of that consultation. Reinitiation was necessary because the exempted amount of take was exceeded in 2013. Additionally, the project description has been modified to add an additional year of sampling (2018). This Opinion is based on the information provided in the EPA Biological Assessment (BA) dated July 25, 2009, and an updated BA and project description which we received on July 6, 2012. Biological Opinions issued by us in 2009, 2010, 2011, 2012, and 2013 were also considered when developing this Opinion. Additional sources of information used in this Opinion include correspondence with EPA staff and MBI, recently published scientific papers, and data collected from previous years' sampling efforts. A complete administrative record of this consultation will be kept on file at our Maine Field Office in Orono, Maine.

1.1 Consultation History

- ***April 1, 2009*** - EPA requested formal consultation with us on the effects of its proposed bio-assessment project in the Kennebec River watershed, Maine.
- ***September 21, 2009*** - We issued a final Biological Opinion concerning EPA's proposed studies on the Kennebec River. We exempted the non-lethal taking of two (2) Atlantic salmon during EPA's 2009 assessments of the Kennebec River; however, no listed species were encountered during the bio-assessment studies in 2009.
- ***August 2, 2010*** - EPA initiated formal consultation with us for the proposed 2010 studies in the Kennebec River.
- ***August, 26, 2010*** - We issued an updated Opinion concerning EPA's proposed studies on the Kennebec River. Based on the 2009 Opinion and the lack of encounters with listed species during the previous year's sampling, we exempted the non-lethal taking of two Atlantic salmon during 2010 assessments. One Atlantic salmon experienced a non-lethal encounter with sampling gear during the bio-assessment studies in 2010.
- ***July 28, 2011*** - EPA initiated formal consultation with us for the proposed 2011 studies in the Kennebec River.
- ***August, 29, 2011*** - We issued an updated Opinion concerning EPA's proposed studies on the Kennebec River. Based on the previous Opinions and limited encounters with listed species during sampling, we again exempted the non-lethal taking of two Atlantic salmon during 2011 assessments. Five Atlantic salmon were encountered during the 2011

survey.

- ***June 11, 2012*** - EPA initiated formal consultation with us for the proposed 2012 studies in the Kennebec River. Based on an expected higher number of Atlantic salmon in the Kennebec River in 2012, EPA requested an increase in exempted take from two salmon to six salmon for the specific sampling season.
- ***June 21, 2012*** - We acknowledged that we had adequate information with which to proceed with formal consultation.
- ***July 2, 2012*** - Representatives from EPA, MBI, and NMFS discussed the likelihood of the survey continuing into the future, and the potential for an extended consultation period to administratively cover biological sampling through 2016. All parties were amenable to the proposition.
- ***July 6, 2012*** - We received an updated Biological Assessment (BA) to reflect a multi-year bio-assessment survey.
- ***September 19, 2012*** - We issued an updated Opinion concerning EPA's proposed studies on the Kennebec River. The consultation covered a five- year period, 2012-2016. Based on previous encounters with listed species, we exempted the non-lethal taking of 20 Atlantic salmon over the term of the consultation. We also exempted the non-lethal taking of one Atlantic sturgeon during the five-year period.
- ***September 25, 2012 –*** EPA advised us of a non-lethal taking of an Atlantic salmon.
- ***September 26, 2012 –*** EPA advised us of a non-lethal taking of an Atlantic sturgeon.
- ***October 11, 2012 –*** EPA advised us of the non-lethal taking of three shortnose sturgeon.
- ***August 2, 2013*** - EPA requested re-initiation of formal consultation with us on the effects of its proposed bio-assessment project in the Kennebec River watershed, Maine.
- ***August 6, 2013 –*** Re-initiation of formal consultation commenced.
- ***September 24, 2013*** - We issued an updated Opinion concerning EPA's proposed studies on the Kennebec River. The consultation covered the five year period, 2013-2017. Based on previous encounters with listed species, we exempted the non-lethal taking of 20 Atlantic salmon over the term of the consultation. We also exempted the non-lethal taking of one Atlantic sturgeon and one shortnose sturgeon during each of the next five years.
- ***August 6, 2014 –*** EPA advised us of a non-lethal taking of an Atlantic sturgeon.
- ***August 8, 2014 –*** EPA advised us of a non-lethal taking of a second Atlantic sturgeon.
- ***August 15, 2014*** - EPA requested re-initiation of formal consultation with us on the effects of its proposed bio-assessment project in the Kennebec River watershed, Maine.
- ***August 18, 2014 –*** Re-initiation of formal consultation commenced.

1.2 Relevant Documents

The analysis in this Opinion is based on a review of the best available scientific and commercial information. Specific sources are listed in Section 10 and are cited directly throughout the body of the document. The impetus for this Opinion was the exceedance of exempted take of Atlantic sturgeon and EPA's request for re-initiation of formal consultation, dated August 15, 2014.

Primary sources of information include: 1) Information provided in EPA's June 11, 2012 initiation letter and attached Project Description and BA for New England Rivers and Streams Fish Assemblage Assessments, dated July 25, 2011; 2) Subsequent edits and revisions to the BA (July 6, 2012); 3) Determination of Endangered Status for the Gulf of Maine Distinct Population

Segment of Atlantic salmon; Final Rule (74 FR 29345; June 19, 2009); 4) Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006); 5) Designation of Critical Habitat for Atlantic salmon Gulf of Maine Distinct Population Segment (74 FR 29300; June 19, 2009); 6) Final Recovery Plan for Shortnose Sturgeon (December, 1998); 7) Determination of Threatened Status for the Gulf of Maine Distinct Population Segment of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (77 FR 5880; February 6, 2012); and 8) the results of EPA's 2012 and 2013 sampling sessions, as well as the initial sampling results from 2014.

1.3 Application of ESA Section 7(a)(2) Standards – Analytical Approach

This section describes the approach used in this Opinion to apply the standards for determining jeopardy and destruction or adverse modification of critical habitat, as set forth in section 7(a)(2) of the ESA and as defined in 50 CFR § 402.02. Additional guidance for this analysis was provided by the Endangered Species Consultation Handbook (March 1998), issued jointly by us and the U.S. Fish and Wildlife Service (USFWS). In conducting an analysis of an action under section 7 of the ESA, we take the following steps:

- Identify the action area, based on the extent of the effects of the proposed action (Section 2 of this Opinion);
- Evaluate the current status of the affected species with respect to biological requirements indicative of survival and recovery and the essential features of any designated critical habitat (Section 3);
- Evaluate the relevance of the environmental baseline in the action area to biological requirements and the species' current status, as well as the status of any designated critical habitat (Section 4);
- Evaluate the relevance of climate change to the environmental baseline and status of the species (Section 5);
- Determine whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 6);
- Determine and evaluate any cumulative effects within the action area (Section 7); and
- Evaluate whether the effects of the proposed action, taken together with any cumulative effects and the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the affected species, or are likely to destroy or adversely modify their designated critical habitat (Section 8).

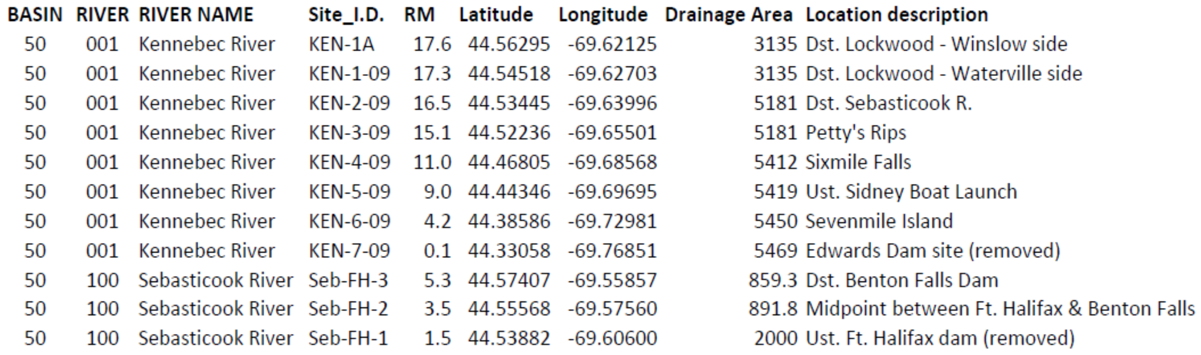
In completing the last step, we determine whether the action under consultation is likely to jeopardize the continued existence of any ESA-listed species or result in the destruction or adverse modification of designated critical habitat. If so, we must identify reasonable and prudent alternatives (RPAs) to the action as proposed that avoid jeopardy or adverse modification of critical habitat and meet the other regulatory requirements for an RPA (see 50 CFR § 402.02). An Incidental Take Statement (ITS) shall be provided to the action agency in instances where we conclude that the proposed action and the resultant incidental take will not violate ESA section 7(a)(2). The ITS includes reasonable and prudent measures, which are those measures necessary and appropriate to minimize incidental take of a listed species. In making these determinations, we must rely on the best available scientific and commercial data. We can also suggest conservation recommendations, which are discretionary agency measures 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 critical habitat analysis determines whether the proposed action will destroy or adversely modify designated or proposed critical habitat for ESA-listed species by examining any change in the conservation value of the primary constituent elements of that critical habitat. This analysis focuses on statutory provisions of the ESA, including those in section 3 of the Act that define "critical habitat" and "conservation," in section 4 of the ESA that describe the designation process, and in section 7 of the ESA that set forth the substantive protections and procedural aspects of consultation. Although some "properly functioning" habitat parameters are generally well-known in the fisheries literature (e.g., thermal tolerances), for others, the effects of any adverse impacts are considered in more qualitative terms. The analysis presented in this Opinion does not rely on the regulatory definition of "adverse modification or destruction" of critical habitat at issue in the 9th Circuit Court of Appeals case *Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service*, No. 03-35279 (9th Cir. 2004).

2. PROJECT DESCRIPTION AND PROPOSED ACTION

U.S. EPA, Region 1 is proposing to fund a multi-year biological assessment project in the Kennebec and Sebasticook Rivers in Maine that will continue through 2018. The project includes a fish assemblage survey based on a single gear electrofishing methodology. The methodology is applied within a standardized seasonal index period of July 1- September 30 (through October 15 in coastal rivers). The project has been designed to document changes in fish assemblages following the removal of the Edwards Dam in 1999 and has been ongoing since 2002. The study, as it has in the past, will follow the Index of Biotic Integrity (IBI) study design (see below), which involves conducting electrofishing surveys in eight randomly-selected 1 km (0.62 mile) reaches of the Kennebec River adjacent to the shoreline (Table 1). Additionally, three reaches in the Sebasticook River will be similarly electrofished to document changes in fish assemblages following the removal of the Ft. Halifax Dam in 2008 (Figure 1).

Table 1. Description of survey locations.



BASIN	RIVER	RIVER NAME	Site_I.D.	RM	Latitude	Longitude	Drainage Area	Location description
50	001	Kennebec River	KEN-1A	17.6	44.56295	-69.62125	3135	Dst. Lockwood - Winslow side
50	001	Kennebec River	KEN-1-09	17.3	44.54518	-69.62703	3135	Dst. Lockwood - Waterville side
50	001	Kennebec River	KEN-2-09	16.5	44.53445	-69.63996	5181	Dst. Sebasticook R.
50	001	Kennebec River	KEN-3-09	15.1	44.52236	-69.65501	5181	Petty's Rips
50	001	Kennebec River	KEN-4-09	11.0	44.46805	-69.68568	5412	Sixmile Falls
50	001	Kennebec River	KEN-5-09	9.0	44.44346	-69.69695	5419	Ust. Sidney Boat Launch
50	001	Kennebec River	KEN-6-09	4.2	44.38586	-69.72981	5450	Sevenmile Island
50	001	Kennebec River	KEN-7-09	0.1	44.33058	-69.76851	5469	Edwards Dam site (removed)
50	100	Sebasticook River	Seb-FH-3	5.3	44.57407	-69.55857	859.3	Dst. Benton Falls Dam
50	100	Sebasticook River	Seb-FH-2	3.5	44.55568	-69.57560	891.8	Midpoint between Ft. Halifax & Benton Falls
50	100	Sebasticook River	Seb-FH-1	1.5	44.53882	-69.60600	2000	Ust. Ft. Halifax dam (removed)

EPA is proposing to provide funding to the Midwest Biodiversity Institute (MBI) to complete a contract to carry out this work. In keeping with the methodology established by Yoder *et al.* in 2006 (*i.e.*, "the Index of Biotic Integrity (IBI) approach"), electrofishing will be conducted from a boat at each electrofishing site during the fall (September/October).

2.1 Field Sampling Methods

Methods for the collection of fish in the survey are based on the IBI methodology. For each sampling site, IBI-type sampling will occur over a 1 km long transect with the sampling equipment described below. A total of eight sites will be sampled biannually (September and October) in the lower Kennebec River between the Lockwood Dam in Waterville downstream to the site of the former Edwards Dam in Augusta, which is at the head of tide (Table 1). Three additional sites will be sampled annually (September) in the Sebasticook River between the Benton Falls Dam in Benton Falls and the former Ft. Halifax Dam site in Winslow (Table 1).

Figure 1. Map of survey area and significant landmarks.

2.2 Electrofishing Methodology

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

An electrofishing boat will make a single pass along each transect, traveling approximately 1 km along the shoreline. Electric currents will be applied to maintain power densities sufficient to generate electrotaxis in targeted fish (*i.e.*, shad, salmon, sturgeon, and eels). Minimum settings will be estimated by measuring water conductivity and evaluating behavioral responses of fish prior to changing settings. Efforts to adjust settings will favor low frequency and pulse width to minimize any injuries to fish. Target electrical currents are 2 to 4 amps, 400 volts, and 60 pulses per second. Based upon these settings, the expected range of electrotaxis for fish in the electric field will be approximately 4.5 meters (15 feet) in diameter down to a depth of approximately 2.5 meters (8 feet). During sampling, the anode and cathode will be held as far apart as practical to generate a more diffuse field in order to minimize the risk of injury to fish. Stunned fish will be captured using hand-held nets and removed from the water as rapidly as possible. Listed species, *i.e.*, salmon and sturgeon, will not be netted or handled.

Captured fish will be immediately placed in aerated live wells containing ambient river water. Each transect typically takes 45 minutes to complete, with an additional 45 minutes to process all of the fish captured. The total time each fish is held will vary; however, since fish will be processed after each transect, the maximum holding time for any one fish will be 90 minutes. Captured fish will be identified to species, weighed, enumerated, and released alive.

Individual electrofishing sites are located along the shoreline with the most diverse habitat features, in accordance with established methods (Yoder *et al.* 2006 a,b). This is generally along the gradual outside bends of larger rivers, but it can vary. Sampling distance is determined with a GPS unit and/or laser range finder.

2.3 Sampling Procedure

A boat-rigged, pulsed DC electrofishing apparatus will be used to sample fish. The electrofishing apparatus will be housed in a 4.9 meter- (16 foot) long john boat specifically constructed and modified for electrofishing. In shallow areas, a 14-foot raft will be used. Electric current will be converted, controlled, and regulated by a Smith-Root 2.5 or 5.0 GPP alternator-pulsator that produces up to 1,000 volts DC at 2-20 amperes, depending on the relative conductivity. The pulse configuration consists of a fast-rise, slow-decay wave that can be adjusted to 30, 60, or 120 Hz (pulses per second). Generally, electrofishing is conducted at 60 or 120 Hz, depending on which selection is producing the optimum combination of voltage and amperage output and most effectively and safely stunning fish. The voltage range is selected based on what percentage of the power range produces the highest amperage readings. Generally, the high range is used at conductivity readings less than 50-100 $\mu S/cm^2$, and the low range is used at higher conductivities up to 1200 $\mu S/cm^2$. Lower conductivities usually produce lower amperage readings.

The electrode array on the 16- foot long boat consists of four 8-foot long cathodes (negative polarity; 1inch diameter flexible steel conduit) suspended from the bow and either two or three gangs of anodes (positive polarity), depending on the conductivity of the water, suspended from a retractable aluminum boom. The raft configuration is similar, except there are six cathodes in two gangs of three suspended from the sides of the raft. In both platforms, the gangs of anodes consist of four 3/8-inch woven steel cable strands (each 4 feet in length) formed into a “gang” by binding them together near the attachment point on the boom. These gangs are added or detached as conditions change; anodes are increased (three gangs) at low conductivity and reduced (two gangs and/or fewer wires) at high conductivity. The anodes are suspended from a retractable aluminum boom that extends 2.75 meters in front of the bow on the 16-foot boat and 2.5 meters on the 14-foot raft. The width of both arrays is 0.9 meters. Anodes and cathodes are replaced when they are lost, damaged, or become worn. For night sampling, 100-Watt floodlights are fixed on the guardrail and side rails on the netting platform located on the bow of the 16-foot boat; the 14-foot raft is not used at night. The floodlights are powered by the 12-volt DC output of the 5.0 GPP generator. Auxiliary lighting includes headlamps worn by the sampling crew and handheld lamps of 500,000 to 1,000,000 candle power. The 16-foot boat electrofishing crew consists of a boat driver and two netters; the 14-foot raft crew consists of a raft driver and one netter.

For boat and raft electrofishing at individual sampling locations, the accepted procedure is to slowly and methodically maneuver the electrofishing boat in a down-current direction along the shoreline, maneuvering in and around submerged cover to advantageously position the netters to pick up stunned and immobilized fish. This may require frequent turning, backing, shifting between forward and reverse, changing speed, etc., depending on current velocity and cover density and variability. Although sampling effort is measured by distance, the time fished is an important indicator of adequate effort. Time fished can vary over the same distance, as dictated by cover and current conditions and the number of fish encountered. In all cases, there is a minimum time that should be spent sampling each zone regardless of the catch. In practice, this is generally in the range of 2000-2500 seconds for 0.5 km, but could range upwards to 3500-4000 seconds where there is extensive instream cover and slack flows. For the 1.0 km standard distance, the minimum sampling time was determined to be from 3000-4000 seconds for impounded and tidal sites and 3500-4500 seconds or more at riverine sites.

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

2.4 Field Sample Processing Procedures

Captured fish are immediately placed in an on-board live well for processing. Water is replaced regularly in warm weather to maintain adequate dissolved oxygen levels in the water and to minimize mortality. Aeration will be provided to further minimize stress and mortality. Every effort is made to minimize holding and handling times. Standard handling procedures are employed for all non-listed species. Fish that are not retained for voucher or other purposes are released back into the water after they are identified to species, examined for external anomalies, and weighed.

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

Fish weighing less than 1000 grams are weighed to the nearest gram on a spring dial scale (1000 g x 2g) or a 1000 g hand held spring scale. Fish weighing more than 1000 grams are weighed to the nearest 25 grams on a 12 kg spring dial scale (12 kg x 50 g) or a 50 kg hand held spring scale. For samples comprised of two or more distinct size classes of fish of the same species, such as young of the year, juveniles, and adults, the size classes are processed separately.

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

Fish preserved for future identification are preserved in borax buffered 10% formalin and labeled by date, river or stream, and geographic identifier (e.g., river mile). Non-indigenous species may be kept and appropriately disposed of out of the water, per the request of the state management agencies.

2.5 Electrofishing Effective Range

The electrofishing method as described generally produces an electric field of approximately 4.5-5.5 meters (15-18 feet) in diameter and depths of up to 2.5-3.5 meters (8-11 feet). It is most effective along the shoreline and adjacent to hard structures such as bedrock ledges, woody debris, and hard substrates. The effective extent of the electric field is species-dependent, based on the susceptibility of each species to the electric field. The size of individual fish also affects their susceptibility to being influenced by the electric field. Generally, larger fish are the most susceptible, as the voltage gradient increases with length, but the method is generally effective for all sizes of fish >25 cm (10 inches).

2.6 Sampling Site Configuration

The sampling sites are generally located immediately adjacent to the shoreline or submerged features such as bedrock ledges and gravel shoals. Generally, the "deepest side" of the river with the "best combination and heterogeneity of habitat, flow, and structural cover" is thoroughly sampled. A 1.0 km site typically requires between 3600 and 5400 seconds of "current time," *i.e.*, the cumulative time that the electric field is activated within a site (the netters operate a foot pedal switch, and current is applied intermittently). The variance in time fished is affected by site navigability, current velocity, current types, boat maneuverability, and the number of fish collected.

2.7 Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For purposes of this section 7 consultation, the action area is defined as all areas where electrofishing sampling has the potential to affect listed species or critical habitat under our jurisdiction. As discussed below, federally protected Atlantic sturgeon, shortnose sturgeon, and Atlantic salmon are known to occur in the Kennebec River and Sebasticook River. Additionally, the Kennebec River sample sites are within designated critical habitat of Atlantic salmon. As explained above, the action will involve running multiple transects along the shoreline at specific locations in the two rivers. Each transect will result in an electric field 4.5 - 5.5 meters wide, 2.5 - 3.5 meters deep, and 1 km long. Thus, the action area is defined as the reaches of the Kennebec River and Sebasticook River being sampled by the proposed study (Table 1). The proposed action is not expected to have any direct or indirect effects to listed species outside of the eleven discrete areas where electric current may be experienced. To facilitate sample processing, which occurs between survey sites, initial sampling is done upstream and the vessels are allowed to drift downstream to the next survey site. Because of the small vessel size, shallow draft, and slow speed preferred between sites, we do not anticipate any further effects from the proposed action.

3. STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

This section focuses on the status of the listed species and designated critical habitat within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action. We have determined that the action being considered in this biological opinion may affect the following endangered or threatened species and/or designated critical habitat:

Common Name	***Scientific Name***	***ESA Status***
GOM DPS of Atlantic salmon	*Salmo salar*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
GOM DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Threatened
NYB DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered

Critical Habitat
Designated for the Gulf of Maine DPS of Atlantic salmon.

3.1 Gulf of Maine Distinct Population Segment of Atlantic Salmon

The following section describes the Atlantic salmon listing process, provides life history information that is relevant to Atlantic salmon, and then provides information specific to the status of Atlantic salmon in the action area.

3.1.1 Species Description

The Atlantic salmon is an anadromous[1] 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 Housatonic River (Bigelow and Schroeder 1953). In the United States, 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 GOM DPS of anadromous Atlantic salmon was initially listed jointly by the USFWS and NMFS (collectively, the Services) 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 current GOM 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

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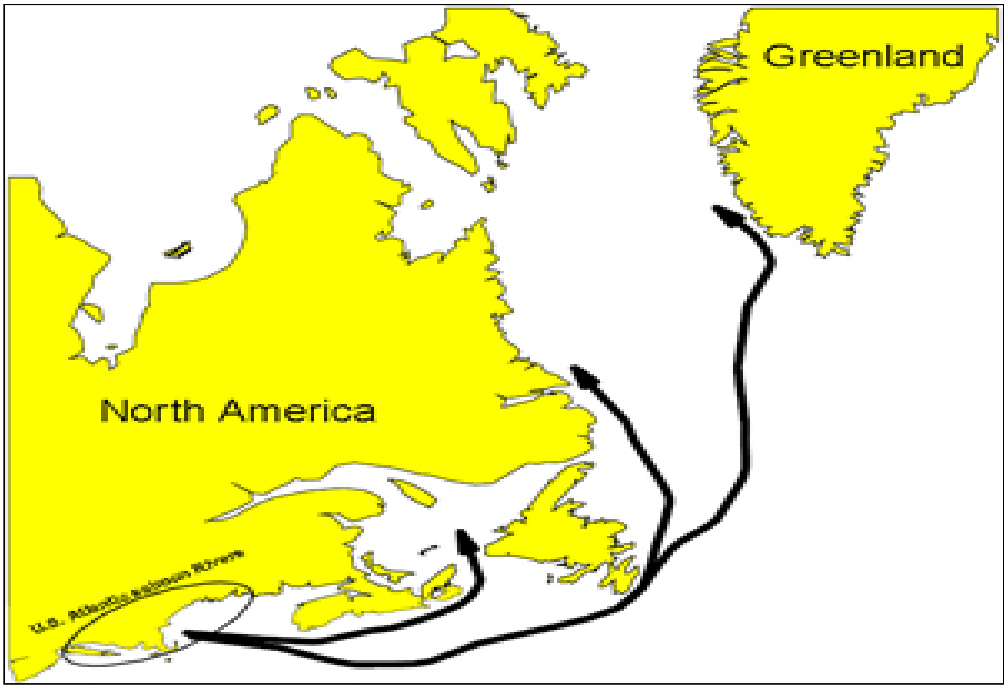
[1] Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn (NEFSC FAQs, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011).

marine range of the GOM DPS extends from the Gulf of Maine, throughout the Northwest Atlantic Ocean, to the coast of Greenland.

Included in the GOM 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 GOM DPS are landlocked Atlantic salmon and those salmon raised in commercial hatcheries for the aquaculture industry.

Atlantic salmon have a complex life history that includes territorial rearing in rivers to extensive feeding migrations on the high seas (Figure 2). During their life cycle, Atlantic salmon go through several distinct phases that are identified by specific changes in behavior, physiology, morphology, and habitat requirements described below.

Figure 2. GOM DPS of Atlantic Salmon Migration Route.



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 GOM 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 refugia (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months. In the fall, female Atlantic salmon selects 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 (McLaughlin and Knight 1987; White 1942), 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 freshwater until the following spring before returning to the sea (Fay *et al.* 2006). From 1996 to 2011, approximately 1.3 percent of the “naturally-reared” adults (fish originating from natural spawning or hatchery fry) in the Penobscot River were repeat spawners (USASAC 2012). Post-spawn adult salmon are referred to as “kelts.”

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 to 35 percent (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 percent) 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.

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.* 1998a; O'Connell and Ash 1993; Erkinaro *et al.* 1995; Dempson *et al.* 1996; Halvorsen and Svenning 2000; Klemetsen *et al.* 2003).

In Maine, most parr (90 percent or more) remain in the river for two to three years before undergoing smoltification, with the balance remaining another one to three years (USASAC 2005). Alternatively, some male parr may not leave the freshwater environments or go through smoltification; these fish may also become sexually mature and may participate in spawning with sea-run adult females and are referred to as "precocious parr." Typically, during 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 during the smoltification process (Schaffer and Elson 1975). 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). These changes also affect visible attributes; the body becomes more streamlined and silvery, with fading parr markings and lengthening and darkening of the margins of the fins producing a pronounced fork in the tail. 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. During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and various predator assemblages.

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 with fish from the same river (Shelton *et al.* 1997).

During the spring of their first year at sea, 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). In 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 - 58^{o}N (Reddin 1985; Reddin and Short 1991; Reddin and

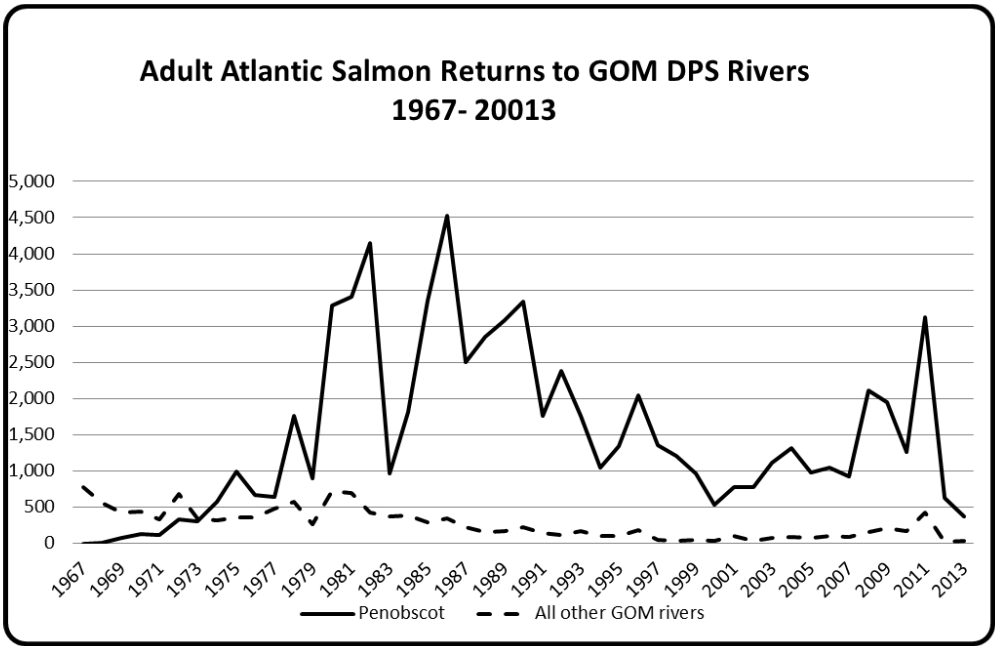
Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish or MSW) and also includes immature salmon from both North American and European stocks (Reddin 1988; Reddin *et al.* 1988). According to research conducted in 1993 by Freidland *et al*., the distribution of winter habitat in the Labrador Sea and Denmark Strait may be influencing survival of migrating adults during their first winter at sea, and may be a limiting factor for North American populations.

Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon overwinter 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.

3.1.2 Status and Trends of Atlantic Salmon in the GOM DPS

The abundance of Atlantic salmon within the range of the GOM 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, Fay *et al.* (2006) present a comprehensive time series of adult returns to the GOM DPS dating back to 1967 (Figure 3). It is important to note that contemporary abundance levels of Atlantic salmon within the GOM 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 GOM DPS have rarely exceeded 5,000 individuals in any given year since 1967 (Fay *et al.* 2006; USASAC 2010).

Figure 3. Adult returns to the GOM DPS Rivers between 1967 and 2013 (Fay *et al.* 2006, USASAC 2001-2013).



Contemporary abundance estimates are informative in considering the conservation status of the GOM DPS today. After a period of population growth in the 1980s, adult returns of salmon in the GOM DPS declined steadily since early 1990s. However, more recently there have been some years with encouraging increases of adult returns, particularly in 2009 and 2011; unfortunately, 2012 and 2013 have continued the downward trend (Figure 3). The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH, which was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s, marine survival rates decreased, leading to the declining trend in adult abundance observed more recently.
Adult returns to the GOM DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Low abundances of both hatchery-origin and naturally-reared adult salmon returns to Maine likely demonstrate continued poor marine survival. Further, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounted for 91 percent of all adult returns to the GOM DPS in 2007. Of the 1044 adult returns to the Penobscot in 2006, 996 of these were stocked smolts and only the remaining 48 were naturally-reared. An average of 1,479 adult salmon have returned to the Penobscot River annually since 2009, peaking at 3,125 in 2011. A record low of 381 salmon returned in 2013; most of these returns were also of hatchery origin (USASAC 2013). In the GOM DPS, nearly all of the hatchery-reared smolts are released into the Penobscot River; more recently, efforts are underway to expand smolt stocking in the Downeast Coastal Salmon Habitat Recovery Unit to increase adult returns.

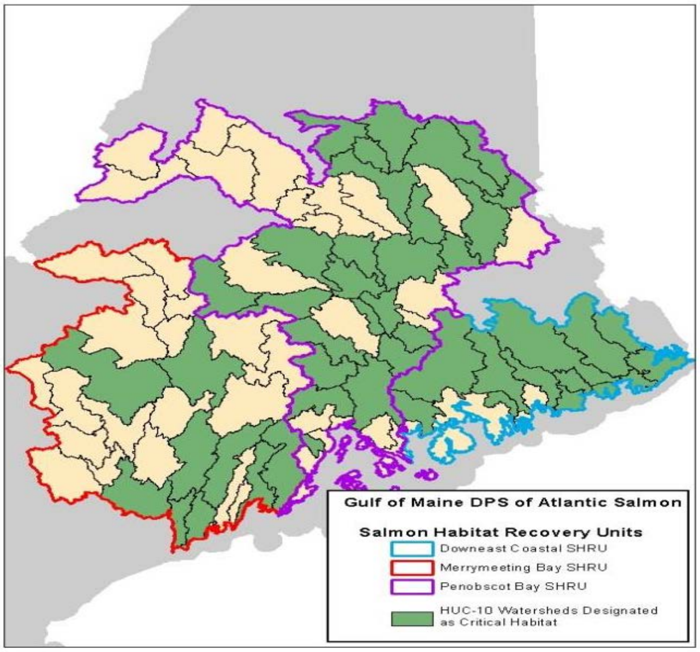
The term naturally-reared includes fish originating from natural spawning and from hatchery fry (USASAC 2012). Hatchery fry are included as naturally-reared because hatchery fry are not marked; therefore, they cannot be distinguished from fish produced through natural spawning. Because of the extensive amount of fry stocking that takes place in an effort to recover the GOM DPS, it is possible that a substantial number of fish counted as naturally-reared were actually stocked as fry.

In conclusion, the abundance of Atlantic salmon in the GOM 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 3% 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 GOM DPS. Continued reliance on the conservation hatchery program could prevent extinction in the short term, but recovery of the GOM DPS must be accomplished through increases in naturally-reared salmon.

3.1.3 Designated Critical Habitat for the GOM DPS of Atlantic Salmon

Coincident with the June 19, 2009 endangered listing, we designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009) (Figure 4). The final rule was revised on August 10, 2009. In this revision, designated critical habitat for the expanded GOM DPS of Atlantic salmon was reduced to exclude trust and fee holdings of the Penobscot Indian Nation and a table was corrected (74 FR 39003; August 10, 2009).

Figure 4. HUC-10 Watersheds Designated as Atlantic Salmon Critical Habitat and Salmon Habitat Recovery Units within the GOM DPS.



The complex life cycles exhibited by Atlantic salmon give rise to complex habitat needs, particularly during the freshwater phase (Fay *et al.* 2006). The status of Atlantic salmon critical habitat in the GOM DPS is important for two primary reasons: a) because it affects the viability of the listed species within the action area at the time of the consultation; and b) because those habitat areas designated "critical" provide primary constituent elements (PCEs) essential for the conservation (*i.e.*, recovery) of the species. For example, spawning gravels must be a certain size and free of sediment to allow successful incubation of the eggs. Eggs also require cool, clean, and well-oxygenated water for proper development. Juveniles need abundant food sources, including insects, crustaceans, and other small fish. They need places to hide from predators (mostly birds and bigger fish), such as under logs, root wads, and boulders in the stream, as well as beneath overhanging vegetation. They also need places to seek refuge from periodic high flows (side channels and off-channel areas) and from warm summer water temperatures (coldwater springs and deep pools). Returning adults generally do not feed in freshwater but instead rely on limited energy stores to migrate, mature, and spawn. Like juveniles, they also require cool water and places to rest and hide from predators. During all life stages, Atlantic salmon require cool water that is free of contaminants. They also need migratory corridors with adequate passage conditions (timing, water quality, and water quantity) to allow access to the various habitats required to complete their life cycle.

3.1.3.1 Primary Constituent Elements of Atlantic Salmon Critical Habitat

Designation of critical habitat is focused on the known PCEs, within the occupied areas of a listed species that are deemed essential to the conservation of the species. Within the GOM DPS, the PCEs for Atlantic salmon are: 1) sites for spawning and rearing, and 2) sites for migration (excluding marine migration[2]). We chose not to separate spawning and rearing habitat into distinct PCEs, although each habitat does have distinct features, because the GIS-based habitat prediction model approach that was used to designate critical habitat (74 FR 29300; June 19, 2009) cannot consistently distinguish between spawning and rearing habitat across the entire range of the GOM DPS.

Physical and Biological Features of the Spawning and Rearing PCE

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

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[2] Although successful marine migration is essential to Atlantic salmon, NMFS was not able to identify the essential features of marine migration and feeding habitat or their specific locations at the time critical habitat was designated.

accommodate parr's ability to occupy many niches and maximize parr production.

6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.
7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and Biological Features of the Migration PCE

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

Habitat areas designated as critical habitat must contain one or more PCEs within the acceptable range of values required to support the biological processes for which the species uses that habitat. Critical habitat includes all perennial rivers, streams, and estuaries and lakes connected to the marine environment within the range of the GOM DPS, except for those areas that have been specifically excluded as critical habitat. Critical habitat has only been designated in areas (HUC-10 watersheds) considered currently occupied by the species. Critical habitat includes the stream channels within the designated stream reach and includes a lateral extent as defined by the ordinary high-water line or the bankfull elevation in the absence of a defined high-water line. In estuaries, critical habitat is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

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

Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

In describing critical habitat for the GOM DPS, we divided the DPS into three Salmon Habitat Recovery Units or SHRUs: the Downeast Coastal, Merrymeeting, and Penobscot Bay. The SHRU delineations were designed by us 1) to ensure that a recovered Atlantic salmon population has widespread geographic distribution to help maintain genetic variability and 2) to provide protection from demographic and environmental variation. A widespread distribution of salmon across the three SHRUs will provide a greater probability of population sustainability in the future, as will be needed to achieve recovery of the GOM DPS.

Areas designated as critical habitat within each SHRU are described in terms of habitat units. One habitat unit represents 100 m^2 of salmon spawning or rearing habitat. The quantity of habitat units within the GOM DPS was estimated through the use of a GIS-based salmon habitat model (Wright *et al.* 2008). For each SHRU, we determined that there were sufficient habitat units available within the currently occupied habitat to achieve recovery objectives in the future; therefore, no unoccupied habitat (at the HUC-10 watershed scale) was designated as critical habitat. A brief historical description for each SHRU, as well as contemporary critical habitat designations and special management considerations, are provided below.

Downeast Coastal SHRU

The Downeast Coastal SHRU encompasses fourteen HUC-10 watersheds covering approximately 747,737 hectares (1,847,698 acres) within Washington and Hancock counties. In this SHRU, there are approximately 59,066 units of spawning and rearing habitat for Atlantic salmon among approximately 6,039 km of rivers, lakes, and streams. Of the 59,066 units of spawning and rearing habitat, approximately 53,400 units in eleven HUC-10 watersheds are considered to be currently occupied. The Downeast Coastal SHRU has enough habitat units available within the occupied range that, in a restored state (e.g. improved fish passage or improved habitat quality), the Downeast Coastal SHRU could satisfy recovery objectives as described in the final rule for critical habitat (74 FR 29300; June 19, 2009). Certain tribal and military lands within the Downeast Coastal SHRU are excluded from critical habitat designation.

Penobscot SHRU

The Penobscot SHRU, which drains approximately 22,234,522 hectares (54,942,705 acres), contains approximately 315,574 units of spawning and rearing habitat for Atlantic salmon among approximately 17,440 km of rivers, lakes, and streams. Of the 315,574 units of spawning and rearing habitat (within 46 HUC-10 watersheds), approximately 211,000 units are considered to be currently occupied (within 28 HUC-10 watersheds). Three HUC-10 watersheds (Molunkus Stream, Passadumkeag River, and Belfast Bay) are excluded from critical habitat designation due to economic impact. Certain tribal lands within the Penobscot SHRU are also excluded from critical habitat designation.

Merrymeeting Bay SHRU

The Merrymeeting Bay SHRU drains approximately 2,691,814 hectares of land (6,651,620 acres) and contains approximately 339,182 units of spawning and rearing habitat for Atlantic salmon located among approximately 5,950 km of historically accessible rivers, lakes, and streams. Of the 339,182 units of spawning and rearing habitat, approximately 136,000 units are considered to be currently occupied. There are forty-five HUC-10 watersheds in this SHRU, but only nine are considered currently occupied. Lands controlled by the Department of Defense within the Little Androscoggin HUC-10 and the Sandy River HUC-10 are excluded as critical habitat. The proposed action will occur entirely within the Merrymeeting Bay SHRU.

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

3.1.4 Status of Atlantic Salmon and Critical Habitat in the Action Area

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section focuses on the status of Atlantic salmon and designated critical habitat in the action area.

The Kennebec River watershed supports a small run of Atlantic salmon. Restoration efforts in the watershed have utilized egg, fry, and parr stocking to promote returning adult salmon. As such, all life stages of Atlantic salmon could be present in the action area of this consultation. From 2003 to 2007, an average of 30,000 fry were released annually to the Sandy River (Paul Christman, MEDMR, personal communication). While this effort produced smolts and adult returns, it was not large enough to boost the population to any great extent. More recently, a large-scale restoration project was initiated utilizing eggs. This effort is more substantial in comparison to previous juvenile introductions. In 2010, 2011, and 2012, approximately 600,000, 860,000 and 920,000 eggs, respectively, were released into the Sandy River. In contrast, only 2,000 fry were released to the Sandy River in 2012. Based upon life-stage survival estimates from literature, the smolt production estimates for each of these cohorts is 9,060, 12,986, and 13,892, respectively. Given that the Sandy River is relatively pristine, it is possible that production could exceed these estimates. In fact, some juvenile production data from the Sandy River suggests these smolt estimates are likely low. The first of these cohorts likely migrated in the spring of 2012. Given an annual supply of eggs for this project, smolt production should continue into the foreseeable future.

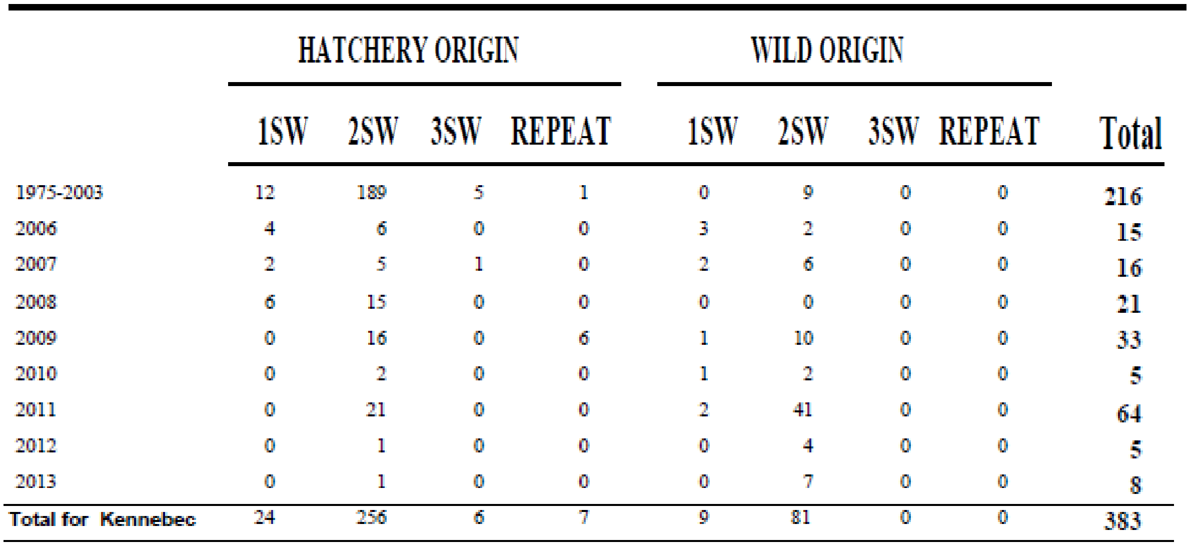
In addition, some Atlantic salmon production may be occurring in Bond Brook, Togus Stream, and the Sebasticook River. In 2010, 30,000 salmon fry were stocked in Togus Stream and Bond Brook. Also in 2010, four adult Atlantic salmon were passed over the Benton Falls Dam in the Sebasticook River. An additional 90 pre-spawn adults were released into the Togus Stream in 2011 (Paul Christman, personal communications, 2012).

3.1.4.1 Atlantic Salmon Adults

Counts for Atlantic salmon in the Kennebec River are available since 2006, when a fishlift was installed at the first dam on the river (Lockwood Dam) (NMFS and USFWS 2009). Adult Atlantic salmon are trapped, and biological data (e.g., fork lengths) are collected before the salmon are trucked and released in the Sandy River, which is an upstream tributary of the Kennebec River containing plentiful spawning and rearing habitat (MEDMR 2011). Returning adult salmon at this first dam on the Kennebec River averaged just under eight fish per year from 1975 to 2000 and nearly 26 fish per year from 2006 to 2011 (Table 2). In 2011, 64 adult Atlantic salmon returned to the Kennebec River (MEDMR 2012).

Monthly return data for 2009 - 2013 indicate peak adult returns to the Kennebec River occur in the months of June and July (Table 3). As of August 18, 2014, fifteen Atlantic salmon have been captured at the Lockwood Dam fishway.

Table 2. Adult Atlantic salmon returns by origin to the Kennebec River recorded from 1975 to 2013.



	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
1975-2003	12	189	5	1	0	9	0	0	216
2006	4	6	0	0	3	2	0	0	15
2007	2	5	1	0	2	6	0	0	16
2008	6	15	0	0	0	0	0	0	21
2009	0	16	0	6	1	10	0	0	33
2010	0	2	0	0	1	2	0	0	5
2011	0	21	0	0	2	41	0	0	64
2012	0	1	0	0	0	4	0	0	5
2013	0	1	0	0	0	7	0	0	8
Total for Kennebec	24	256	6	7	9	81	0	0	383

Data Source: USASAC 2013.

Table 3. Adult Atlantic salmon captured at the Lockwood Project fishlift and translocated to the Sandy River 2009-2013.

Year	**Maturity**	**Month of Capture**						**Total**
		May	**June**	**July**	**Aug**	**Sept**	**Oct**	
2009	MSW Wild ♂	0	2	0	0	0	1	**3**
	MSW Wild ♀	0	2	3	0	0	2	**7**
	MSW Hatchery ♂	0	0	5	0	1	0	**6**
	MSW Hatchery ♀	1	0	6	1	0	0	**8**
	Domestic ♂	1	0	0	0	0	0	**1**

Year	**Maturity**	**Month of Capture**						**Total**
		May	**June**	**July**	**Aug**	**Sept**	**Oct**	
	Domestic ♀	3	0	0	0	0	0	**3**
	Domestic Unk[1]	0	1	0	0	0	0	**1**
	Sub-Total	**5**	**5**	**14**	**1**	**1**	**3**	**29**
2010	MSW Wild ♂	0	0	0	0	0	0	**0**
	MSW Wild ♀	0	2	0	0	0	0	**2**
	MSW Hatchery ♂	0	0	0	0	0	0	**0**
	MSW Hatchery ♀	0	2	0	0	0	0	**2**
	1SW Wild ♂	0	0	0	0	0	1	**1**
	1SW Wild ♀	0	0	0	0	0	0	**0**
	1SW Hatchery ♂	0	0	0	0	0	0	**0**
	1SW Hatchery♀	0	0	0	0	0	0	**0**
	Sub-Total	**0**	**4**	**0**	**0**	**0**	**1**	**5**
2011	MSW Wild ♂	0	9	5	0	1	0	**15**
	MSW Wild ♀	0	12	12	0	0	1	**25**
	MSW Hatchery ♂	0	4	8	0	0	0	**12**
	MSW Hatchery ♀	0	5	3	0	0	0	**8**
	1SW Wild ♂	0	2	0	0	0	0	**2**
	1SW Wild ♀	0	0	0	0	0	0	**0**
	1SW Hatchery ♂	0	0	0	0	0	0	**0**
	1SW Hatchery♀	0	0	0	0	0	0	**0**
	MSW Hatchery (Unk[1])	0	1	0	0	0	0	**1**
	MSW Wild (Unk[1])	0	0	1	0	0	0	**1**
	Sub-Total	**0**	**33**	**29**	**0**	**1**	**1**	**64**

Year	**Maturity**	**Month of Capture**						**Total**
		May	**June**	**July**	**Aug**	**Sept**	**Oct**	
2012	1SW Wild♂	1	2	0	0	0	0	**3**
	1SW Wild♀	0	1	0	0	0	0	**1**
	1SW Hatchery♂	0	0	0	0	0	0	**0**
	1SW Hatchery♀	0	0	0	0	0	0	**0**
	MSW Wild♂	0	0	0	0	0	0	**0**
	MSW Hatchery♀	0	1	0	0	0	0	**1**
	MSW Hatchery (Unk[1])	0	0	0	0	0	0	**0**
	Sub-Total	**1**	**4**	**0**	**0**	**0**	**0**	**5**
2013	1SW Wild♂	0	0	0	0	0	0	**0**
	1SW Wild♀	0	0	0	0	0	0	**0**
	1SW Hatchery♂	0	0	0	0	0	0	**0**
	1SW Hatchery♀	0	0	0	0	0	0	**0**
	MSW Wild♂	0	0	1	0	1	0	**2**
	MSW Wild♀	0	1	3	0	0	0	**4**
	MSW Hatchery♀	0	0	0	0	0	0	**0**
	MSW Hatchery ♂	0	1	0	0	0	0	**1**
	Sub-Total	**0**	**2**	**4**	**0**	**1**	**0**	**7**
Grand Total		**6**	**48**	**47**	**1**	**3**	**5**	**110**

Data Source: MEDMR 2009 -2013. Note: Unk[1] = Sex Unknown

Between 2007 and 2009, manual tracking radio telemetry studies were conducted in the Kennebec River watershed to test if this technology can be used to observe the behavior of adult Atlantic salmon during known spawning periods (MEDMR 2010). Study fish were translocated to the Sandy River in 2007 and 2008, and were monitored into the fall of 2009. Sixteen of the 18 adult salmon tracked in the study were detected in the Sandy River throughout the spawning season, and displayed known migratory patterns throughout their residency in the Sandy River, including longer-range migration after release in the spring, minimal movement in the summer, and short-range migration in the fall during spawning (MEDMR 2010). Only one of the tagged adult salmon migrated downstream before spawning would have occurred. Five of the radio tags were detected in identical locations in 2009 as observed in 2008, and it was determined that these fish regurgitated their tags, or were mortalities. In addition, redd counts and juvenile surveys confirmed that adult salmon translocated to the Sandy River successfully spawned (MEDMR 2010). The total trap catch for 2011 was 64 adult sea-run Atlantic salmon, of which 21 were of hatchery origin two-sea winter (2SW) and 43 were naturally reared (41-2SW, 2-1SW). All 64 adult Atlantic salmon were trucked and released to the Sandy River. As indicated below, the trap catch for 2012 and 2013 combined only totaled 13 adult sea-run Atlantic salmon, of which 2 were of hatchery origin and 11 were naturally reared. Included in this tally is the solitary wild adult Atlantic salmon which was trapped at the Benton Falls Dam fishlift in July 2013. All returning adults during that period had experienced 2 sea winters (2SW). All adult Atlantic salmon trapped in the lower Kennebec River are trucked and released to the Sandy River.

Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea or overwinter in freshwater habitat and migrate in the spring, typically April or May (Baum 1997). Spring flows resulting in spillage at the dams facilitate out-migration of adult salmon (Shepard 1988). The number of kelts in the Kennebec River is proportional to the number of adults entering the river each year to spawn.

3.1.4.2 Juvenile Atlantic Salmon

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

Generally, salmon smolts begin moving out of Maine rivers in mid-April to June. Atlantic salmon smolts originating in the Sandy River will occur in the action area as they migrate to the ocean. Most data concerning the emigration of smolts in Maine have been collected in the Penobscot River. Based on unpublished data from smolt-trapping studies in 2000 – 2005 by our Northeast Science Center, smolts migrate from the Penobscot between late April and early June. The majority of the smolt migration appears to take place over a three to five week period after water temperatures rise to 10°C.

In the springs of 2012, 2013, and 2014 a smolt-trapping study was conducted on the Sandy River, a tributary to the Kennebec River, by NextEra Energy. NextEra Energy installed a rotary screw trap (RST) in the lower reaches to sample out-migrating Atlantic salmon smolts. The Sandy River RST was operational from April 18, 2012 to May 30, 2012, from May 3 to May 23, 2013, and from May 23 to June 2, 2014. A total of 285 smolts were captured during 55 days of sampling, averaging slightly over 5 fish per day. The earliest a smolt was captured was on April 18 and the last smolt was captured on June 2nd. Peak capture of smolts occurred in the second week of May. Ambient water temperatures in the Sandy River ranged from 8° C to 19° C during the sampling periods. While the annual abundance of smolts in the Kennebec River is presently unknown, MEDMR estimates the current egg stocking and natural reproduction in the Sandy River may be producing over 10,000 smolts annually. Smolt abundance in the river is likely to remain stable or grow as restoration efforts in the river continue.

3.1.4.3 Designated Critical Habitat for Atlantic Salmon in the Action Area

As discussed in section 3.1.3, critical habitat for Atlantic salmon has been designated in the Kennebec River watershed. One Primary Constituent Element (PCE) for Atlantic salmon (sites for migration) is present in the action area, as outlined in section 3.1.3.1 of this Opinion.

To facilitate and standardize determinations of effect for section 7 consultations involving Atlantic salmon critical habitat, we developed the "Matrix of PCEs and Essential Features for Designated Atlantic Salmon Critical Habitat in the GOM DPS" (Table 4).

Table 4. Matrix of Primary Constituent Elements (PCEs) and essential features for assessing the status of Atlantic salmon critical habitat in the action area.

		Conservation Status Baseline		
PCE	Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
A) Adult Spawning: (October 1st - December 14th)				
	Substrate	highly permeable course gravel and cobble between 1.2 to 10 cm in diameter	40- 60% cobble (22.5-256 mm dia.) 40-50% gravel (2.2 – 22.2 mm dia.); 10-15% course sand (0.5 -2.2 mm dia.), and <3% fine sand (0.06-0.05mm dia.)	more than 20% sand (particle size 0.06 to 2.2 mm), no gravel or cobble
	Depth	17-30 cm	30 - 76 cm	< 17 cm or > 76 cm
	Velocity	31 to 46 cm/sec.	8 to 31cm/sec. or 46 to 83 cm/sec.	< 5-8 cm/sec. or > 83cm/sec.
	Temperature	7^o to 10^oC	often between 7^o to 10^oC	always < 7^o or > 10^oC
	pH	> 5.5	between 5.0 and 5.5	< 5.0
	Cover	Abundance of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Limited availability of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Absence of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
B) Embryo and Fry				

Development: (October 1st - April 14th)			
Temperature	0.5^{o}C and 7.2^{o}C, averages nearly 6oC from fertilization to eye pigmentation	averages < 4^{o}C, or 8 to 10^{o}C from fertilization to eye pigmentation	>10^{o}C from fertilization to eye pigmentation
D.O.	at saturation	7-8 mg/L	< 7 mg/L
pH	> 6.0	6 - 4.5	< 4.5
Depth	5.3-15cm	NA	<5.3 or >15cm
Velocity	4 – 15cm/sec.	NA	<4 or > 15cm/sec.
Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

		Conservation Status Baseline		
PCE	Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
D) Adult migration: (April 15th- December 14th)				
	Velocity	30 cm/sec to 125 cm/sec	In areas where water velocity exceeds 125 cm/sec adult salmon require resting areas with a velocity of < 61 cm/s	sustained speeds > 61 cm/sec and maximum speed > 667 cm/sec
	D.O.	> 5mg/L	4.5-5.0 mg/l	< 4.5mg/L
	Temperature	14 – 20^{o}C	temperatures sometimes exceed 20^{o}C but remain below 23^{o}C.	> 23^{o}C
	Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	barriers to migration known to cause direct or indirect mortality of smolts
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
E) Juvenile Migration: (April 15th - June 14th)				
	Temperature	8 - 11^{o}C	5 - 11^{o}C.	< 5^{o}C or > 11^{o}C
	pH	> 6	5.5 - 6.0	< 5.5
	Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	barriers to migration known to cause direct or indirect mortality of smolts

The matrix lists the PCEs, physical and biological features (essential features) of each PCE, and the potential conservation status of critical habitat within an action area. The PCEs in the matrix (spawning and rearing, and migration) are described with respect to five distinct Atlantic salmon life stages: (1) adult spawning; (2) embryo and fry development; (3) parr development; (4) adult migration; and (5) smolt migration. The conservation status of the essential features may exist in varying degrees of functional capacity within the action area. The three degrees of functional capacity used in the matrix are described in ascending order: (1) fully functioning; (2) limited function; and (3) not properly functioning. The PCEs present in the action area of this consultation include adult and smolt migration.

Using the matrix (Table 4), along with information presented in EPA's BA and site-specific knowledge of the action area, we determined that the essential feature of adult migration may have limited function in the action area (Table 5), due to delays in migration at dams and increased potential for predation from native and non-native species. However, based on the proposed time of the study, only adult salmon are likely to be affected by the action.

Table 5. Current conditions of essential features of Atlantic salmon critical habitat in the action area that have limited function or are not properly functioning.

Pathway/Indicator	**Life Stages Affected**	**PCE Affected**	**Effect**	**Population Viability Attributes Affected**
Passage/Access to Historical Habitat	Adults	Freshwater migration	Delayed migration	Adult abundance and productivity
Fisheries Interactions	All	Freshwater migration	Increased predation	Abundance and productivity

3.1.5 Factors Affecting Atlantic Salmon

This section provides a summary of factors affecting the entire DPS of Atlantic salmon, factors affecting designated critical habitat of Atlantic salmon, and factors affecting the Atlantic salmon specifically in the action area.

3.1.5.1 Threats to the GOM DPS of Atlantic Salmon

The recovery plan for the previously designated GOM 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 Services have written a new recovery plan that is currently under review; it will include the current, expanded GOM DPS and its designated critical habitat. The new recovery plan provides the most up-to-date list of significant threats affecting the GOM DPS as follows:

- 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
- Climate Change

In addition to these significant threats, the GOM DPS faces the following lesser stressors:

- Degraded water quality
- Aquaculture practices, which pose ecological and genetic risks
- 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
- Recovery 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 (ESA § 4(a)(1); 16 U.S.C. § 1533(a)(1)) and determined that each of the five listing factors is at least partly responsible for the present low abundance of the GOM DPS. The information presented in Fay *et al.* (2006) is reflected in and supplemented by the final listing rule for the new GOM DPS (74 FR 29344; June 19, 2009). The following gives a brief overview of the five listing factors as related to the GOM DPS.

1. **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 GOM 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.

2. **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 GOM DPS. Both poaching and by-catch in recreational and commercial fisheries for other species remain of concern, given critically low numbers of salmon.

3. **Predation and disease –** Natural predator-prey relationships in aquatic ecosystems in the GOM 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 GOM 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 primarily documented at conservation hatcheries and aquaculture facilities.

4. **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 GOM DPS today. Furthermore, most dams in the GOM 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 GOM DPS, including those from the effects of irrigation wells on salmon streams.

5. **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 GOM 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 GOM DPS from aquaculture (including eliminating the use of non-North American Atlantic salmon and improving containment protocols), risks from the spread of diseases or parasites and from farmed salmon escapees interbreeding with wild salmon still exist.

3.1.5.2 Threats to Critical Habitat within the GOM DPS

The final rule designating critical habitat for the GOM DPS identifies a number of activities that have impacted and 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. Most of these activities have occurred or still do occur, at least to some extent, in each of the three SHRUs. Impacts to substrate and cover, water quality, water temperature, biological communities, and migratory corridors, among a host of other factors, have impacted the quality and quantity of habitat available to Atlantic salmon populations within the GOM DPS. Additionally, smallmouth bass and other non-indigenous species (such as brown trout introductions in the Merrymeeting Bay SHRU), significantly degrade habitat productivity throughout each of the SHRUs by altering natural predator/prey relationships.

Today, dams are the greatest impediment, outside of marine survival, to the recovery of salmon in the Penobscot, Kennebec, and Androscoggin river basins (Fay *et al.* 2006). Hydropower dams in the Penobscot and Merrymeeting Bay SHRUs significantly impede the migration of Atlantic salmon and other diadromous fish and either reduce or eliminate access to roughly 350,000 units of historically accessible spawning and rearing habitat. In addition to hydropower dams, agriculture and urban development largely affect the lower third of the Merrymeeting Bay SHRU by altering substrate and cover, reducing water quality, and elevating water temperatures.

In the Downeast Coastal SHRU, two hydropower dams on the Union river, and to a lesser extent the small ice dam on the lower Narraguagus River, limit access to roughly 18,500 units of spawning and rearing habitat within these two watersheds. In the Union River, which contains over 12,000 units of spawning and rearing habitat, physical and biological features have been most notably limited by high water temperatures and abundant smallmouth bass populations associated with impoundments. In the Pleasant River and Tunk Stream, which collectively contain over 4,300 units of spawning and rearing habitat, pH has been identified as possibly being the predominant limiting factor. The Machias, Narraguagus, and East Machias rivers contain the highest quality habitat relative to other HUC 10's in the Downeast Coastal SHRU and collectively account for approximately 40 percent of the spawning and rearing habitat in the Downeast Coastal SHRU.

3.1.5.3 Factors Affecting Atlantic Salmon in the Action Area

Dams

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

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

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

Predation

Predation rates in the Kennebec and Sebasticook rivers are difficult to estimate because of the wide spatial and temporal distribution of Atlantic salmon at low densities and the large number and variety of potential predators (Fay *et al*. 2006). However, predation rates likely increase near barriers such as the Benton Falls and Lockwood dams, where fish migration is delayed and population density increases.

Native and introduced fish species, such as smallmouth bass, chain pickerel, and northern pike are important predators of Atlantic salmon within the range of the GOM DPS (Fay *et al.* 2006). Their predicable out migration period, smaller physical size, and a slower sustained swimming speed make salmon smolts a much more attainable prey item when compared to adult salmon. 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 also prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell (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 are likely the most important avian predators of Atlantic salmon in freshwater environments. The abundance of alternative prey resources, such as upstream migrating alewife, likely minimizes the impacts of avian predators on the GOM DPS (Fay *et al*. 2006).

Water Quality

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

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

Over 200 miles of the Kennebec River and its tributaries, including all 10 reaches where sampling is proposed, are listed as impaired (MEDEP 2013). In their 2012 Integrated Water Quality Monitoring and Assessment Report, the Maine Department of Environmental Protection (MEDEP) describes the Kennebec and Sebasticook River action areas as impaired due to elevated levels of two environmentally persistent carcinogenic compounds: dioxin and polychlorinated biphenyls (PCBs). Combined sewer overflows (CSOs) from Skowhegan to the Gardiner-Randolph region on the river produce elevated bacteria levels, inhibiting recreational uses of the river (primary contact). Further, the Kennebec River has fish consumption restrictions due to the presence of dioxin from industrial point sources. The Sebasticook River is also contaminated with PCBs and other persistent hazardous materials. Pollution has long been a major problem for this river system, including current discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons) as well as legacy pollutants such as PCBs.

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

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

3.1.6 Efforts to Protect the GOM DPS and its Critical Habitat

Efforts aimed at protecting Atlantic salmon and their habitats in Maine have been underway for well over one hundred years. A wide variety of activities have focused on protecting Atlantic salmon and restoring stream connectivity within the GOM DPS, including (but not limited to): 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 restoration strategies. These efforts are supported by a number of federal, state, and local government agencies, as well as many non-governmental conservation organizations.

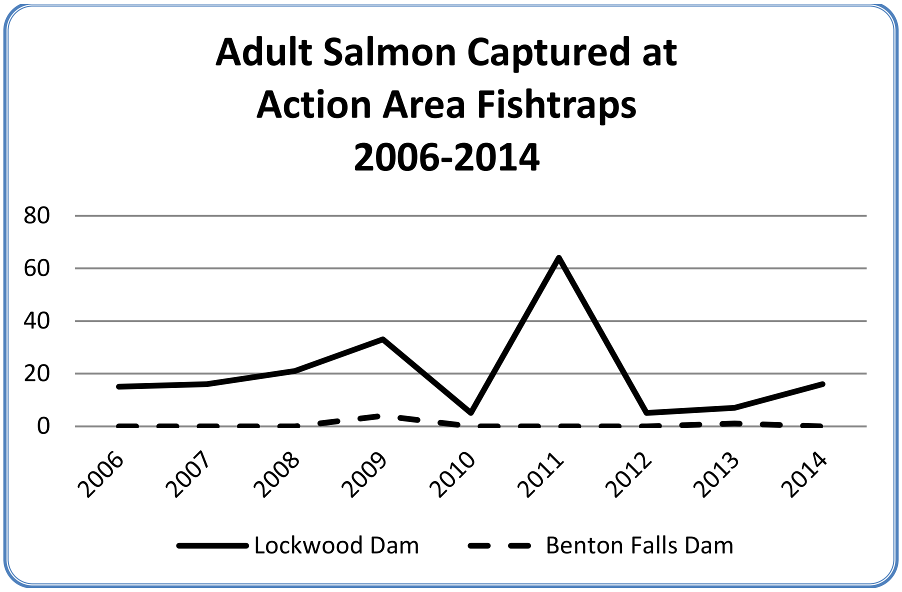
In light of the 2009 GOM DPS listing and designation of critical habitat, the Services, in collaboration with the State of Maine and the Penobscot Indian Nation, developed a recovery framework that identifies how these resource agencies and the Tribe will work together to achieve recovery for Atlantic salmon. The Framework consists of seven action teams: Conservation Hatchery, Genetics, Freshwater, Connectivity, Marine and Estuarine, Stock Assessment, and Education and Outreach. Teams include scientists and managers from federal, tribal, and state agencies with specific skills and expertise. They may also include outside experts who provide technical, scientific, or feasibility information. The guiding Framework document identifies three primary objectives to focus our efforts: 1) Abundance; 2) Distribution; and 3) Ecosystem Function and Diversity. It also includes specific actions identified by each action team that can be undertaken to work towards recovering Atlantic salmon. Framework meetings which are open to the public are held regularly in order to also engage the general public in Atlantic salmon recovery efforts.

A recovery plan was developed by the Services when Atlantic salmon were first listed under the ESA. However, with the expanded listing that occurred in 2009, this recovery plan lacked information on recovery efforts for Atlantic salmon in a significant geographic portion of the newly expanded range of the DPS, which included additional threats that were either not present or very limited in the range of the original DPS (e.g., large, hydropower-producing dams). Thus, the Services are currently working on a recovery plan that covers the full range and scope of threats to the listed DPS.

3.1.7 Summary of Information on Atlantic Salmon in the Action Area

For all GOM DPS rivers in Maine, including the Kennebec and Sebasticook,current Atlantic salmon populations (including hatchery contributions) are well below conservation spawning escapement (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 GOM 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. Due, in part, to the migratory barriers, degraded water quality, and increased predation, adult salmon returns to the Kennebec and Sebasticook river action areas (and the DPS in general) have not been naturally sustainable for many years.

Figure 5. Adult salmon returns to the Kennebec and Sebasticook river fish lifts since 2006.



Since the action area lies entirely within the Merrymeeting Bay SHRU and is influenced by upstream events, a number of activities occurring there will likely continue to impact the biological and physical features of 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 non-native biological communities, have reduced the quality and quantity of habitat available to Atlantic salmon populations within the proposed action area and the Merrymeeting Bay SHRU in general.

3.2 Shortnose Sturgeon

3.2.1 Species Description

Shortnose sturgeon are large, long-lived, 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, isopods), insects, and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm 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), 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), which is the rate of mortality based on the sum of natural mortality and mortality resulting from fishing, are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980), and Pee Dee-Winyah River (0.08-0.12; Dadswell *et al.* 1984). Total instantaneous natural mortality (M), which is a measure of the removal of fish from the stock due to causes not associated with fishing, was estimated to be 0.13 for shortnose sturgeon in the lower Connecticut River (T. Savoy, Connecticut Department of Environmental Protection).

Because there is no commercial fishery for the species, fish aren't physically handled and counted on an annual basis (fisheries dependent data). There is no recruitment information available for shortnose sturgeon because it is usually derived from fisheries dependent data. In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river, which is the case for the 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^{o} - 9.7ºC (44.6^{o} - 49.5°F), 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. 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 a study in the Androscoggin River, adults returned to a 1 km reach below the Brunswick Dam, and Kieffer and Kynard (1996) found that adults spawned within a 2 km 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 8^{o} - 15ºC (46.4^{o} - 59°F), and bottom water velocities of 0.4 to 0.8 m/sec (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^{o} - 18.0ºC (Kieffer and Kynard 2012).

Movement to the spawning grounds occurs in early spring (April - May) in the Kennebec River. Movement to the spawning areas is triggered in part by water temperature, and fish typically arrive at the spawning locations when water temperatures are between 8^{o}-9°C (46.4^{o}-48.2^{o}F). Shortnose sturgeon typically spawn at the most upstream accessible site with suitable conditions. Spawning sites have been identified in the Kennebec River near Gardiner, downstream of the survey area. However, since the removal of the Edwards Dam, near Augusta, in 1999, shortnose sturgeon have been able to travel an additional 30 kilometers upstream to the Lockwood Dam at Waterville. Based on this pattern, it is likely that shortnose sturgeon may now be spawning in additional upriver sites.

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 tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes, move upstream in spring, and feed mostly in freshwater reaches during summer.

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/kg body weight (Dadswell *et al.* 1984).

Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.* 1984). Between 8°C (46.4°F) and 12°C (53.6°F), 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.

At hatching, shortnose sturgeon are blackish-colored, 7-11 mm 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 mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20 mm (0.79 inch) 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 mm (2.24 inches) 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 or 42 (Parker 2007).

The juvenile phase can be subdivided into young of the year (YOY) and immature/subadults. YOY and subadult 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 salt wedge 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). Subadults are typically described as age one or older and occupy similar spatio-temporal patterns and habitat-use as adults (Kynard 1997), though there is evidence from the Delaware River that subadults may overwinter in different areas than adults and do not form dense aggregations like adults (ERC Inc. 2007). Subadults 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).

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 large numbers of shortnose sturgeon do not regularly undertake the significant marine migrations seen in Atlantic sturgeon, telemetry data indicates that shortnose sturgeon do make localized coastal migrations (Fernandes *et al.* 2010; Zydlewski *et al.* 2011; Little *et al.* 2013). This is particularly true within certain areas such as the Gulf of Maine (GOM) and among rivers in the Southeast. Many of the river systems within the species range are separated by considerable distances; others are geographically close and sometimes share a river mouth or estuary. Intra-basin movements have been documented among rivers within the GOM. Inter-basin movements have been documented between the GOM rivers and the Merrimack River, the Connecticut and Hudson rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

During the period 2009 through 2013, researchers from U.S. Geologic Survey (USGS), University of New England (UNE), University of New Hampshire (UNH), and Maine Department of Marine Resources (MEDMR) tagged and tracked four individual shortnose sturgeon that migrated north from the Merrimack River (Little *et al*. 2013). Most of these fish were subsequently identified in the Piscataqua and Saco Rivers and then detected entering the Kennebec River, where they remained for 2-3 weeks before returning to the Merrimack via the Saco and Piscataqua. (Micah Kieffer, personal conversation, 2013). These same fish made multiple coastal migrations during the five-year study period. These telemetry data suggest that shortnose sturgeon tagged in the Merrimack River are making regular coastal migrations to the Kennebec River, most likely to participate in spawning aggregations.

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 2^o to 3ºC (35.6^o-37.4°F) (Dadswell *et al.* 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). However, water temperatures above 28ºC (82.4°F) are thought to adversely affect shortnose sturgeon. In the Altamaha River (GA), water temperatures of 28^o-30ºC (82.4^o-86°F) 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 meter (approximately 2 feet) is necessary for unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30 meters (98.4 ft.) but are generally found in waters less than 20 meters (65.5 ft.) (Dadswell *et al.* 1984; Dadswell 1979). 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; Squires and Smith 1979). McCleave *et al.* (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10 ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989); however, shortnose sturgeon forage on vegetated mudflats and over shellfish beds in shallower waters when suitable forage is also present.

3.2.2 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 were commonly taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). 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 recoveries, 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 (NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the International Union for the Conservation of Nature (IUCN) Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan we 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). We have not formally recognized distinct population segments (DPS) 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 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 comprised 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 populations in the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, inter-orbital 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 inter-orbital width and lateral scute counts, which suggest 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 nonglaciated 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 eleven 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 five 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. These differences likely account 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 Saint John River in New Brunswick, Canada. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes vary across the species range. From available estimates, the smallest populations occur in the Cape Fear River (≈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, personal communication 2012; 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, Kynard (1996) estimated that the expected abundance of adults in northern and north-central populations should be in the thousands to tens of 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 population rangewide, 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.

Recently, academic studies on shortnose sturgeon have been focusing on the species' use of small coastal rivers and inter-basin movements, such as the utilization of the St. George and/or Damariscotta Rivers while migrating between the Kennebec and Penobscot Rivers. However, telemetry data collected between May of 2009 and November of 2013 by University of New England (UNE) researchers indicated significant coastal migration (>100 km) by six shortnose sturgeon (Little *et al.*, 2013). The six tagged fish originated in the Merrimack River (MA) and rested or foraged in several smaller rivers along the Maine coast before being detected in the Kennebec.

As discussed above, researchers from USGS, UNE, UNH, and MEDMR also tagged and tracked four individual shortnose sturgeon that migrated north from the Merrimack River. The timing of coastal migrations by fish originating in the Merrimack and the duration of their stay in the Kennebec (April–May) is consistent with the known spawning period in the Kennebec/Androscoggin system (Squiers *et al.*, 1982). Considering the recent telemetry detections, it is reasonable to expect listed shortnose sturgeon to be present in the action area during the survey period. Based on life history patterns, such as overwintering and spawning runs, coupled with telemetry data, shortnose sturgeon are most likely to occur in the action area in mid to late spring, when the water temperature is warmer than 8^{o}C.

Studies indicate that at least a portion of the shortnose sturgeon population in the Kennebec River overwinters in Merrymeeting Bay (Squires 2003). For several years, shortnose sturgeon were documented overwintering in an area at the confluence of the Eastern and Kennebec rivers near Swan Island. However, during the overwintering periods 2011-2012 and 2012-2013, shortnose sturgeon overwintered in the deep water channels between Hallowell and Farmingdale, Maine, approximately one kilometer upstream of Brown's Island (G. Wipplehauser, MEDMR, personal communication 2013).

3.2.3 Threats to Shortnose Sturgeon Recovery Rangewide

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. Recently, climate change has also been identified as a major threat to the species rangewide.

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). In-water or nearshore 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 drag arms 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 re-suspended 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 riverine habitat, 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 bottom-dwelling organisms (Varanasi 1992) like sturgeon. Heavy metals and organo-chlorine 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 suggest 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 organo-chlorine 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 organo-chlorine 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, and DDE (an organo-chlorine pesticide) were detected in the "adverse effect" 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.

Pulp mills, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which may contain elevated water 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 (82.4°F) (Flourney *et al.* 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC (82.4ºF). 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.

Many ecosystems are highly vulnerable to the projected rate and magnitude of climate change. While it is possible that some species will adapt to changes in climate by shifting their ranges, human and geographic barriers and the presence of invasive non-native species will likely limit the degree that adaptation can occur. Losses in local biodiversity are likely to accelerate towards the end of the 21st century.

3.2.4 Threats to Shortnose Sturgeon Recovery in the Action Area

Shortnose sturgeon, like all diadromous fishes, occupies a host of habitats at various points in their life, including: rivers, estuaries, bays, and coastal marine waters. Habitat alterations potentially affecting shortnose sturgeon include loss of access to historical habitat, loss of and alteration of spawning habitat, poor water quality and changes to water flow, substrate alteration, siltation, and contamination. Loss of habitat and poor water quality has contributed to the decline of shortnose sturgeon since the time of European settlement; however, the importance of this threat is especially pertinent to potential spawning grounds and overwintering areas. The up- and downstream boundaries (dam sites) of the action area are among the most densely populated areas in the state, and as a result of human manipulation, water quality and quantity have varied over time. However, some important aspects of habitat quality have improved during the last thirty years, including the termination of log drives, the regulation of in-water work such as dredging, and improved water quality through the systematic elimination of combined sewer outfalls. Climate change also is a threat to shortnose sturgeon recovery in the action area, as discussed in the Climate Change section below (Section 5).

3.2.5 Status of Shortnose Sturgeon in the Action Area

Shortnose sturgeon are listed as endangered as a single species throughout their range. To date, critical habitat has not been designated for shortnose sturgeon. Below, we present information on the use of the action area by shortnose sturgeon.

In 1999, the Edwards Dam at Augusta, which represented the first significant impediment to the upstream migration of shortnose sturgeon (and the downstream extent of the action area) in the Kennebec River, was removed. With the removal of the dam, approximately 17 miles of previously inaccessible sturgeon habitat north of Augusta was made available. In order to monitor the recolonization of the habitat above Edwards Dam, MEDMR conducted an ichthyoplankton survey from 1997 through 2001. Twelve sampling sites were established above the former dam site and thirteen sites were established below the former dam site. While no shortnose sturgeon eggs or larvae were collected above the former dam site in 2000 or 2001 (Wippelhauser 2003), small numbers of eggs and larvae were collected at sites in the first nine kilometers below the site (rkm 61-70). Tom Squiers (MEDMR) hypothesized that the major spawning area for shortnose sturgeon in the Kennebec River was likely located in the first 11 km below the former Edwards Dam site (rkms 59-70). On May 11, 1999, 135 shortnose sturgeon were caught in the Kennebec River 10 km below Edwards Dam (rkm 60) and were assumed to be on the spawning run. Water temperature was 14°C.

Aside from the initial studies (1997-2001), no further research has been conducted to determine if shortnose sturgeon spawning activity occurred above the former Edwards Dam. Other research activities for shortnose sturgeon conducted by University of Maine investigators are ongoing and authorized through scientific research permits issued by us through 2017 (See section 4.2). Several shortnose sturgeon have been captured incidental to other studies in Waterville (and some at the base of the Lockwood Dam), 27 km above the former Edwards Dam, since its removal. A Schnabel estimate using tagging and recapture data from 1998, 1999, and 2000 indicates a population estimate of 9,488 (95% CI, 6,942 to 13,358) for the entire estuarine complex (Squires 2003). The average density of adult shortnose sturgeon per hectare of habitat in the estuarine complex of the Kennebec River was the second highest of any population studied through 1983 (Dadswell *et al.* 1984). Shortnose sturgeon occupy the Kennebec River year-round and migrate up and downstream seasonally between overwintering habitat, spawning grounds, and foraging areas.

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

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

3.3 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 which Atlantic sturgeon DPSs likely occur in the action area and provide information on the use of the action area by Atlantic sturgeon.

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott, 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). NMFS has delineated U.S. populations of Atlantic sturgeon into five DPSs (77 FR 5880 and 77 FR 5914, February 6, 2012). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (see Figure 6). The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King, 2011). However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, 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.

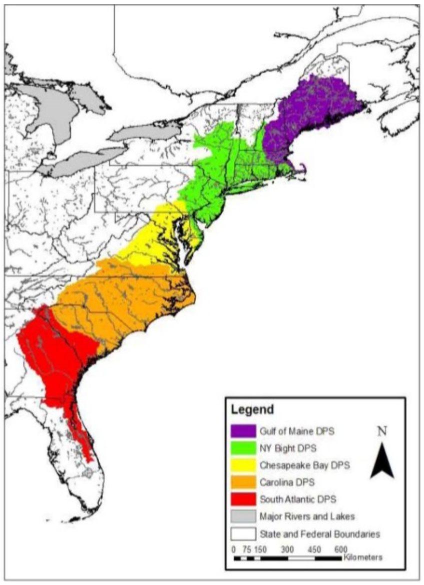
The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered, and the Gulf of Maine DPS is listed as threatened (77 FR 5880 and 77 FR 5914, February 6, 2012). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings.

As described below, individuals originating from all five listed DPSs may occur in the action area. Information general to all Atlantic sturgeon as well as information specific to each of the relevant DPSs, is provided below.

3.3.1 Determination of DPS Composition in the Action Area

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida (Scott and Scott 1988; ASSRT, 2007). We have delineated U.S. populations of Atlantic sturgeon into five DPSs[3] (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (Figure 6).

Figure 6. Map Depicting the Boundaries of the Five Atlantic sturgeon DPSs



The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered, and the Gulf of Maine DPS is listed as threatened. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listing. The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King 2011). However, genetic data, as well as tracking and tagging data, demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, 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.

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[3] 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.”

As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. The distribution of Atlantic sturgeon is influenced by geography, with Atlantic sturgeon from a particular DPS becoming less common the further from the river of origin one moves. Areas that are geographically close are expected to have a similar composition of individuals. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated.

A mixed stock analysis is available for the Bay of Fundy (≈93% Gulf of Maine DPS (≈60% St. John, ≈40% Kennebec) and ≈6% New York Bight DPS). However, there is currently no mixed stock analysis for the Kennebec River. Given the geographic proximity of the Bay of Fundy to the action area, it is reasonable to anticipate similar distribution in these two areas. However, in the action area we would expect a higher frequency of Kennebec River origin individuals than St. John River individuals. As such, in the action area we expect Atlantic sturgeon to occur at the following frequencies: Gulf of Maine DPS ≈93% (≈60-100% Kennebec and≈0-40% St. John (Canada)) and ≈0-6% New York Bight DPS. These occurrences are supported by preliminary genetic analyses of fish caught in the Gulf of Maine. The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation, we have selected the reported values above, which approximate the mid-point of the range, as 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 by Damon-Randall *et al.* (2012). Information general to all Atlantic sturgeon, as well as information specific to each of the relevant DPSs, is provided below.

3.3.2 Atlantic sturgeon life history

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[4] fish (Bigelow and Schroeder, 1953; Vladykov and Greeley 1963; Mangin, 1964; Pikitch *et al.*, 2005; Dadswell, 2006; ASSRT, 2007).

The life history of Atlantic sturgeon can be divided up into five general categories as described in the table below (adapted from ASSRT 2007).

Age Class	**Size**	**Description**
Egg		Fertilized or unfertilized
Larvae		Negative photo-taxic, nourished by yolk sac

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[4] 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)

Age Class	**Size**	**Description**
Young of Year (YOY)	**0.3 grams <41 cm TL**	Fish that are > 3 months and < one year; capable of capturing and consuming live food
Non-migrant subadults or juveniles	**>41 cm and <76 cm TL**	Fish that are at least age 1 and are not sexually mature and do not make coastal migrations.
Subadults	**>76cm and <150cm TL**	Fish that are not sexually mature but make coastal migrations
Adults	**>150 cm TL**	Sexually mature fish

Table 6. Descriptions of Atlantic sturgeon life history stages.

Atlantic sturgeons are bottom feeders that suck food into a ventrally-located protruding mouth (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, insect larvae, and other invertebrates (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007).

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; and, (3) fully mature females attain a larger size (i.e. length) than fully mature males (Smith *et al.*, 1982; Smith *et al.*, 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 4 million eggs per spawning year, females spawn at intervals of 2-5 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 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman, 1997). Males exhibit spawning periodicity of 1-5 years (Smith, 1985; Collins *et al.*, 2000; Caron *et al.*, 2002).

Water temperature plays a primary role in triggering the timing of spawning migrations

(ASMFC, 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; ASMFC, 2009), and remain on the spawning grounds throughout the spawning season (Bain, 1997). Females begin spawning migrations when temperatures are closer to 12° C 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 cm/s and depths are 3-27 m (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; ASMFC, 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; ASMFC, 2009), and become adhesive shortly after fertilization (Murawski and Pacheco, 1977; Van den Avyle, 1983; 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 egg deposition (ASSRT, 2007).

Larval Atlantic sturgeon (i.e. less than 4 weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam *et al.* 1996) are assumed to undertake a demersal existence and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.*, 1980; Bain *et al.*, 2000; Kynard and Horgan, 2002; ASMFC, 2009). Studies suggest that age-0 (i.e., young-of-year), 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 m 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.*, 2004; USFWS, 2004; Laney *et al.*, 2007; Dunton *et al.*, 2010; Erickson *et al.*, 2011; Wirgin and King, 2011).

3.3.3 Distribution and Abundance

In the mid to late 19th century, Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing for the caviar market (Scott and Crossman 1973; Taub 1990; Kennebec River Resource Management Plan 1993; Smith and Clugston 1997; Dadswell 2006; ASSRT 2007). At the time of the listing, there were 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 to 1995 (Kahnle *et al.*, 2007). An estimate of 343 spawning adults per year is available for the Altamaha River, GA, 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 (see Kocik et al. 2013). 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 (see Table 7). The ASPI provides a general abundance metric to assess risk for actions that may affect Atlantic sturgeon in the ocean. 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[5], and federal fishery discard estimates from 2006 to 2010 to produce a virtual population.

In additional to the ASPI, a population estimate was derived from the Northeast Area Monitoring and Assessment Program (NEAMAP) (Table 8). 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 and spring. Fall surveys have been ongoing since 2007 and spring surveys since 2008. Each survey employs a spatially stratified random design with a total of 35 strata and 150 stations.

Table 7. Description of the ASPI model and NEAMAP survey based area estimate method.

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[5] 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.

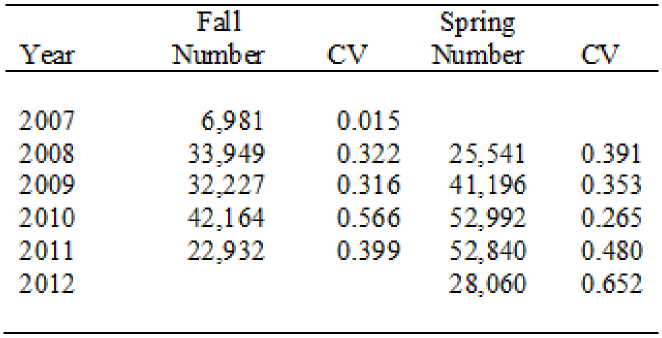
Model Name	Model Description
A. ASPI	Uses tag-based estimates of recapture probabilities from 1999 to 2009. Natural mortality based on Kahnle *et al.* (2007) rather than estimates derived from tagging model. Tag recaptures from commercial fisheries are adjusted for non-reporting based on recaptures from 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.

Table 8. Modeled Results

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 information from the NEAMAP survey can be used to calculate minimum swept area population estimates within the strata swept by the survey. 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 8). 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 ratio of total sturgeon habitat to area sampled by the NEAMAP survey is unknown, but is certainly greater than one (i.e. the NEAMAP survey does not survey 100% of the Atlantic sturgeon habitat).

Table 9. Annual minimum swept area estimates for Atlantic sturgeon during the spring and fall from the Northeast Area Monitoring and Assessment Program survey. Estimates assume 100% net efficiencies. Estimates provided by Dr. Chris Bonzek, Virginia Institute of Marine Science (VIMS).



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

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 in Kocik et al. (2013) for catchabilities from 5 to 100%. In estimating the efficiency of the sampling net, we consider the likelihood that an Atlantic sturgeon in the survey area is likely to be captured by the trawl. 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. In estimating the fraction of the Atlantic sturgeon population within the sampling area of the NEAMAP, we consider that the NEAMAP-based estimates do not include young of the year fish and juveniles in the rivers where the NEAMAP survey does not sample. Although the NEAMAP surveys are not conducted in the Gulf of Maine or south of Cape Hatteras, NC, the NEAMAP surveys are conducted from Cape Cod to Cape Hatteras at depths up to 18.3 meters (60 feet), which includes the preferred depth ranges of subadult and adult Atlantic sturgeon. NEAMAP surveys take place during seasons that coincide with known Atlantic sturgeon coastal migration patterns in the ocean. The NEAMAP estimates are minimum estimates of the ocean population of Atlantic sturgeon based on sampling in a large portion of the marine range of the five DPSs, in known sturgeon coastal migration areas during times that sturgeon are expected to be migrating north and south.

Based on the above, we consider that the NEAMAP samples an area utilized by Atlantic sturgeon, but does not sample all the locations and times where Atlantic sturgeon are present and the trawl net captures some, but likely not all, of the Atlantic sturgeon present in the sampling area. Therefore, we assumed that net efficiency and the fraction of the population exposed to the NEAMAP survey in combination result in a 50% catchability. The 50% catchability 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.

The ASPI model projects a mean population size of 417,934 Atlantic sturgeon and the NEAMAP Survey projects mean population sizes ranging from 33,888 to 338,882 depending on the assumption made regarding efficiency of that survey (see Table 8). The ASPI model uses estimates of post-capture survivors and natural survival, as well as probability estimates of recapture using tagging data from the U. S. Fish and Wildlife Service (USFWS) sturgeon tagging database, and federal fishery discard estimates from 2006 to 2010 to produce a virtual population. The NEAMAP estimate, in contrast, does not depend on as many assumptions. For the purposes of this Opinion, we consider the NEAMAP estimate resulting from the 50% catchability rate, as the best available information on the number of subadult and adult Atlantic sturgeon in the ocean.

The ocean population abundance of 67,776 fish estimated from the NEAMAP survey assuming 50% efficiency (based on net efficiency and the fraction of the total population exposed to the survey) was subsequently partitioned by DPS based on genetic frequencies of occurrence (Table 10) in the sampled area. 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. 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 sink gillnet and otter trawl gear in the marine environment and are present in the marine environment, which is only a fraction of the total number of subadults.

The ASMFC has initiated a new stock assessment with the goal of completing it by the end of 2015. We 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 10. Summary of calculated population estimates based upon the NEAMAP Survey swept area assuming 50% efficiency (based on net efficiency and area sampled) derived from applying the Mixed Stock Analysis to the total estimate of Atlantic sturgeon in the Ocean and the 1:3 ratio of adults to subadults)

DPS	Estimated Ocean Population Abundance	Estimated Ocean Population of Adults	Estimated Ocean Population of Subadults (of size vulnerable to capture in fisheries)
GOM	7,455	1,864	5,591
NYB	34,566	8,642	25,925
CB	8,811	2,203	6,608
Carolina	1,356	339	1,017
SA	14,911	3,728	11,183
Canada	678	170	509

3.3.4 Threats faced by Atlantic sturgeon throughout their range

Atlantic sturgeon are susceptible to over exploitation given their life history characteristics (e.g., late maturity, dependence on a wide-variety of habitats). 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 that make up the DPS can affect 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 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, we concluded that unintended catch of Atlantic sturgeon in fisheries, vessel strikes, poor water quality, water 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 of 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 the Labrador, Canada to Cape Canaveral, FL, 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, given that Atlantic sturgeon depend on a variety of habitats, every life stage is likely affected by one or more of the identified threats.

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. Complementary regulations were implemented by NMFS in 1999 that prohibit fishing for, harvesting, possessing or retaining Atlantic sturgeon or its parts in or from the Exclusive Economic Zone 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 Gulf of Maine and the New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO, 2010; 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 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 likely originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Individuals from all 5 DPSs are caught as bycatch in fisheries operating in U.S. waters. 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 (NMFS NEFSC 2011) in the Northeast 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 2011). The analysis prepared by the NEFSC estimates that from 2006 through 2010 there were 2,250 to 3,862 encounters per year in observed gillnet and trawl fisheries, with an average of 3,118 encounters. Mortality rates in gillnet gear are approximately 20%. Mortality rates in otter trawl gear are believed to be lower at approximately 5%.

3.3.5 Gulf of Maine DPS of Atlantic Sturgeon

The Gulf of Maine DPS includes the following: all anadromous Atlantic sturgeons that 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, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot rivers (ASSRT 2007). Spawning still occurs in the Kennebec River, 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; however, the extent of spawning in this river is unknown. 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 percent 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) (Keiffer 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 these rivers. Atlantic sturgeons that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the Gulf of Maine DPS, as well as likely throughout the entire range (ASSRT 2007; Fernandes, *et al.* 2010).

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 1998; NMFS and USFWS 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) capture of 31 adult Atlantic sturgeon from June 15,1980, 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 4 ripe males and 1 ripe female captured on July 26,1980; and, (3) 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, ME (NMFS and USFWS 1998; ASMFC 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. In August 2014, when two Atlantic sturgeon were encountered, Jason Bartlett (MEDMR) was onboard the sampling vessel. He suggested the sturgeon were late leaving the (freshwater) system because of cooler water temperature and higher stream flows.

Several threats play a role in shaping the current status of Gulf of Maine 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). Following the 1880s, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. 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 occurring in state and federal waters still occurs. In their marine range, Gulf of Maine DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.* 2004; ASMFC 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 Gulf of Maine region have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine region. 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; however, as noted above, not all projects are monitored for interactions with fish. 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; we 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 sites of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon are known to 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. While not expected to be killed or injured during passage at a dam, the extent that Atlantic sturgeon are affected by the existence of dams and their operations in the Gulf of Maine region is currently unknown.

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

Gulf of Maine 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, especially the Androscoggin River, were heavily polluted in the past from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many persistent pollutants remain 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 empirical abundance estimates for the Gulf of Maine DPS of Atlantic sturgeon. The ASSRT (2007) presumed that the Gulf of Maine DPS was comprised of less than 300 spawning adults per year, based on abundance estimates for the Hudson and Altamaha River 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.

3.3.5.1 Summary of the Gulf of Maine DPS of Atlantic Sturgeon in the Action Area

Spawning by the GOM DPS of Atlantic Sturgeon occurs at discrete sites in the Kennebec River approximately 10 miles downstream of the action area, but not in the approximately 15 mile reach that comprises the action area. There are indications of increasing abundance of Atlantic sturgeon in the Kennebec River belonging to the Gulf of Maine DPS as shown by the recent increase in detections by in-river telemetry arrays and by encounters with MBI’s electrofishing gear. These observations suggest that abundance of the Gulf of Maine 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.

3.3.6 New York Bight DPS of Atlantic Sturgeon

The New York Bight DPS includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, MA to the Delaware-Maryland border on Fenwick Island. 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 prior to the onset of expanded exploitation in the 1800s is unknown but has been conservatively estimated at 10,000 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 River 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. No data on abundance of juveniles are available prior to the 1970s; however, 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 6 year classes, excluding young of year.

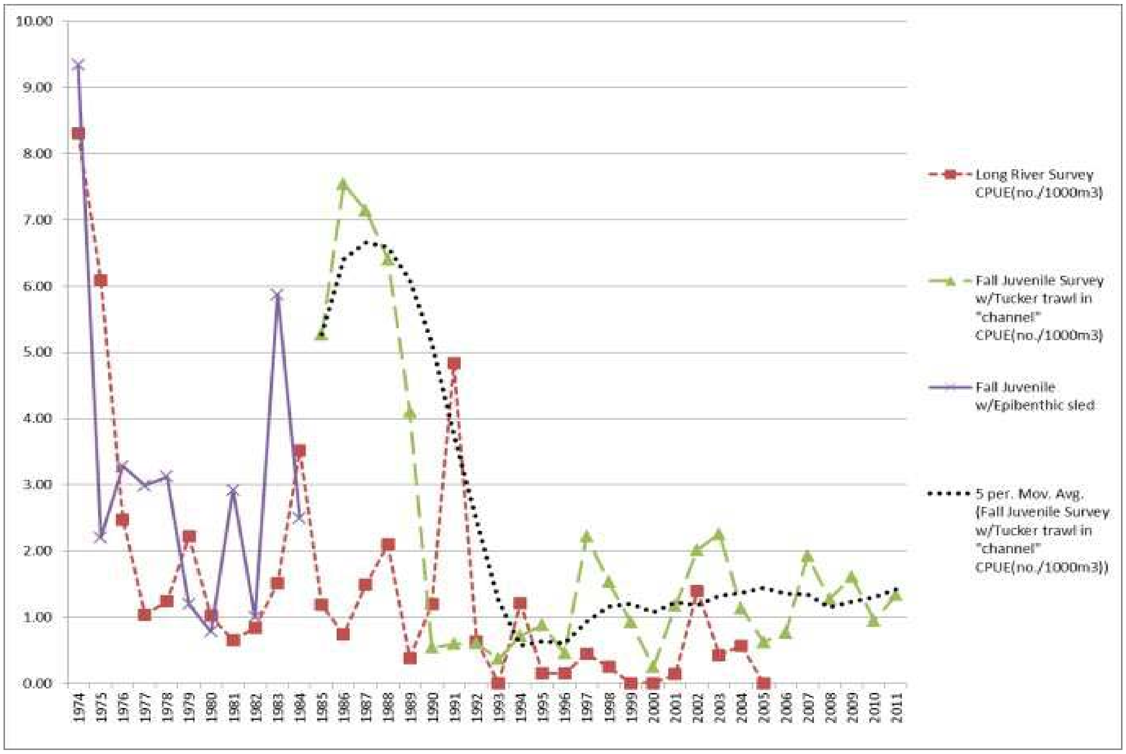
In October of 1994, the New York State Department of Environmental Conservation (NYDEC) stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews 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 catch per unit effort (CPUE) of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since that time.

The Long River Survey (LRS) sampled ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which were 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 inter-annual 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 about the same time (1996) 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 period 2003-2005, the number of juveniles collected increased each year, which could be indicative of an increasing trend for juveniles. As evidenced by estimates of juvenile abundance, the Atlantic sturgeon population in the Hudson River has declined over time. Peterson *et al.* (2000) found that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. Similarly, long-term indices of juvenile abundance (the Hudson River Long River and Fall Shoals surveys) demonstrate a long term declining trend in juvenile abundance. Figure 7, below, illustrates the CPUE of Atlantic sturgeon in the two long-term surveys of the Hudson River. Please note that the Fall Shoals survey switched gear types in 1985. We do not have the CPUE data for the Long River Survey for 2006-2011.

Figure 7. CPUE of Atlantic sturgeon in the two long term surveys of the Hudson River.



CPUE for the Fall Juvenile Survey for the most recent five year period (2007 - 2011) is approximately 27% of the CPUE from 1985 - 1990, but is more than two times higher than the CPUE from 1991-1996, which may be suggestive of an increasing trend in juvenile abundance. Given the high variability between years, it is difficult to use these data to assess short-term trends, however, when looking at a five-year moving average, the index appears to be increasing from lows in the early 1990s, but is still much lower than the 1970s and 1980s.

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800's 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 young-of- the year (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 mm 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 the 2009 year class YOY indicates that at least 3 females successfully contributed to the 2009 year class (Fisher 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning is still occurring in the Delaware River, the relatively low numbers suggest the existing riverine population is limited in size.

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; however, at this time we do not have information to quantify this threat or its impact to the population or the New York Bight DPS. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population.

3.3.6.1 Summary of the New York Bight DPS of Atlantic Sturgeon in the Action Area

As noted above, there are no current, published population abundance estimates for any of the currently known spawning stocks. Therefore, there are no published abundance estimates for any of the five DPSs of Atlantic sturgeon. Only a small proportion (<6%) of Atlantic sturgeon encountered in the Gulf of Maine could be expected to have originated from the NYB DPS (Damon-Randall *et al*. 2012). Considering this, the number of Atlantic sturgeon in the Kennebec River action area that may have originated from the NYB DPS is extremely low.

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

4. ENVIRONMENTAL BASELINE

The environmental baseline for a biological opinion includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). An environmental baseline that does not meet the biological requirements of a listed species may increase the likelihood that adverse effects of the proposed action will result in jeopardy to a listed species or in destruction or adverse modification of designated critical habitat. In addition, the environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species and may affect critical habitat in the action area.

4.1 Formal or Early Section 7 Consultations

We completed two ESA section 7 consultations for the Lockwood Hydroelectric Project (2005; 2013). Lethal and non-lethal take of shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon was exempted in the Lockwood Hydroelectric Project Opinion (2013).

We have completed five formal consultations concerning EPA's support of long-term bio-assessment studies in the Kennebec River (2009, 2010, 2011, 2012, and 2013). We exempted the non-lethal take of adult Atlantic salmon in all five consultations, the non-lethal take of adult Atlantic sturgeon in the 2012 and 2013 consultations, and the non-lethal take of adult shortnose sturgeon in the 2013 consultation. No salmon were encountered in 2009. One Atlantic salmon was encountered in 2010. In 2011, five Atlantic salmon were encountered. Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon were all encountered during the 2012 sampling season. In an attempt to eliminate the need for annual re-initiation of formal consultation while acknowledging the potential for an increase in encounters with listed species during EPA's 2013 survey, in 2012, we extended the time period covered by our Opinion to five years and exempted the non-lethal take of four Atlantic salmon and one Atlantic sturgeon in each of the five years covered by the consultation. In 2013, we issued a new Opinion for a new five year period and exempted the non-lethal take of four Atlantic salmon, one Atlantic sturgeon, and one shortnose sturgeon in each of the five years covered by the consultation. The amount of exempted take provided for the 2014 sampling season in the 2013 Opinion was exceeded during the first week of sampling (August 6-8, 2014), as a result of the taking of two Atlantic sturgeon.

4.2 Scientific Studies

MEDMR is authorized under the USFWS' endangered species blanket permit (No. 697823) to conduct monitoring, assessment, and habitat restoration activities for listed Atlantic salmon populations in Maine. The extent of take from MEDMR activities during any given year is not expected to exceed 2% of any life stage being impacted, except that for adults, it would be less than 1%. MEDMR will continue to conduct Atlantic salmon research and management activities in the Kennebec River watershed while the EPA's proposed action is carried out. The information gained from these activities will be used to further salmon conservation actions in the GOM DPS.

We are also a sub-permittee under USFWS' ESA section 10 endangered species blanket permit. Research authorized under this permit is currently ongoing regarding Atlantic salmon populations in the Merrymeeting Bay SHRU. Although these activities will result in some take of Atlantic salmon, adverse impacts are expected to be minor and such take is authorized by an existing ESA permit. The information gained from these activities will be used to further salmon conservation actions in the GOM DPS.

USFWS is also authorized under an ESA section 10 endangered species blanket permit to conduct a 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 GOM DPS are currently provided through production at these two hatcheries. The hatcheries provide a significant buffer from extinction for the species.

Research activities for shortnose sturgeon conducted by University of Maine investigators are authorized through scientific research permits issued by us. Permit number 16306 was issued in May 2012 and authorizes research activities into 2017. The research team consists of scientists from MEDMR, USGS, UM, and the University of Southern Maine. Their research objectives are to: 1) use mark-recapture techniques to generate population estimates and to define stock structure and distribution, 2) determine the degree of demographic correspondence and connectivity of local in-river sturgeon populations, and 3) identify habitat use, movement patterns, and life history characteristics of shortnose sturgeon in Maine waters. The treatments would include weighing, measuring, photographing, anesthetizing, inserting PIT tag, Floy/T-bar tag insertion, tissue sample, blood sample, boroscope, gastric lavage, fin ray section, apical spine sample, and external satellite tagging. Not all specimens sampled would receive all treatments. The research sites include the Penobscot, Kennebec, Saco, and Merrimack Rivers. Additionally, several smaller coastal rivers in Maine and New Hampshire will also be surveyed. The section 10 permit allows the directed non-lethal take of 7,205 shortnose sturgeon of various life stages over the duration of the permit, with 200 deliberate mortalities of early life stage (ELS) occurring annually. A portion of that take is expected to occur in the Kennebec River. The Biological Opinion issued as a result of section 7 consultation on the effects of the directed take authorized under Permit 16306 concluded that this take is not likely to jeopardize the continued existence of any ESA-listed species under NMFS jurisdiction.

Maine DMR also holds a Section 10(a)(1)(A) Permit to conduct scientific research on Atlantic sturgeon in the Kennebec River (Permit 16526). The permit is valid from April 2012 – April 2017. The permit authorizes (annually) capturing, handling, tagging, weighing and releasing 225 juvenile or adult Atlantic sturgeon each year. The permit also authorizes the lethal capture of up to 100 Atlantic sturgeon eggs and larvae. The Biological Opinion issued as a result of section 7 consultation on the effects of the directed take authorized under Permit 16526 concluded that this take is not likely to jeopardize the continued existence of any ESA-listed species under NMFS jurisdiction.

4.3 State or Private Activities in the Action Area

Through a letter of memorandum signed on January 12, 2001, the EPA has delegated the National Pollutant Discharge Elimination System (NPDES) program to the State of Maine Department of Environmental Protection. We have provided comments on the proposed relicensing of the Kennebec Sanitary Treatment District's facility at Waterville as well as the Winslow combined sewer outfall; details of those permits are provided below. No interactions with Atlantic salmon or listed sturgeon have been reported in association with either of those projects.

4.3.1 Publicly Owned Waste Treatment Facilities

The Kennebec Sanitary Treatment District owns and operates a wastewater treatment facility that discharges secondary treated effluent to the Kennebec River. Located approximately three kilometers downstream of the Lockwood Dam, the US EPA classifies the facility as a major discharger of effluents based on factors such as flow volume, toxic pollutant potential, and public health impacts. The facility is authorized to discharge an average of 12.7 million gallons per day of secondary treated sanitary wastewater under the Maine Pollution Discharge Elimination System (MPDES) permit number ME0100854. The Waste Discharge License (WDL) W-000687 issued concurrently with the MPDES permit also authorized the discharge of an unspecified amount of untreated combined sanitary and storm water during wet weather events from three other combined sewer outfalls that discharge to the action area. According to the EPA's Enforcement and Compliance History Online (ECHO) website, the facility has exceeded its authorized concentration or volume of a variety of pollutants six different times in a three year period (2010-2013), and has been in violation of its permit during 11 of 13 reporting periods (quarters) since 2011 (EPA, 2014a).

The Town of Winslow also owns and operates a combined sewer outfall under MEPDES permit ME0102628 and WDL W-008204 that discharges to the Sebasticook River approximately 250 meters upstream from its confluence with the Kennebec River. The Town reported discharging an estimated 1.3 million gallons of combined wastewater in 2012. As of August 26, 2014, the Winslow facility is in a Category II - reportable non-compliance violation status (EPA 2014b).

In addition to the POTWs addressed above, there was also a private wastewater treatment facility that discharged to the Kennebec River. Located less than 700 meters upstream of the old Edwards Dam site, the facility was licensed to Augusta Tissue LLC under MEPDES permit number ME00002224 as recently as 2005, but it has since been demolished and the permit was allowed to expire.

4.3.2 State Authorized Fisheries

Shortnose and Atlantic sturgeon are taken incidentally in anadromous fisheries along the East Coast and may be targeted by poachers (NMFS 1998, ASSRT 2007). The Kennebec River is an important corridor for migratory movements of various species including alewife (*Alosa pseudohernegus*), American eel (*Anguilla rostrata*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), striped bass (*Morone saxatilis*) and lobster (*Homarus americanus*). Historically, the river and its tributaries supported the largest commercial fishery for shad in the State of Maine. However, pollution and the construction of dams decimated the shad runs in the late 1920s and early 1930s. Shortnose sturgeon in the Kennebec River may have been taken as bycatch in the shad fishery or other fisheries active in the action area. It has been estimated that approximately 20 shortnose sturgeon are killed each year in the commercial shad fishery and an additional number are also likely taken in recreational fisheries (T. Savoy pers. comm. in NMFS 1998). However, the incidental take of shortnose sturgeon in the river has not been well documented due to confusion over distinguishing between Atlantic sturgeon and shortnose sturgeon. Due to a lack of reporting, no information on the number of shortnose or Atlantic sturgeon caught and released or killed in commercial or recreational fisheries on the Kennebec River is available.

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

4.4 Impacts of Other Human Activities in the Action Area

The past and present impacts of all Federal, State, and private actions on each of the three listed species in the action area are described above in the discussions of the status and trends of the species and the factors affecting them.

Other human activities that may affect listed species and critical habitat include direct and indirect modification of habitat due to hydroelectric facilities' alteration of the river's natural flow pattern and temperatures. During dam maintenance, silt and other fine river sediments can be released and subsequently deposited in sensitive spawning habitat downstream. These facilities also act as barriers to normal upstream and downstream movements and block access to important habitats. Passage through these facilities may result in the mortality of downstream migrants. Since the upstream limits of the action areas in both rivers are delineated by hydroelectric dams, the indirect effects to listed species from dam operations do occur. However, the intensity of the stressor and the species' response to the stressor is often based on the life stage of the individual and/or the habitat type affected. Because known sturgeon spawning habitat is over 20 miles downstream from the closest dams (and 10 miles beyond the action area), we don't anticipate the dams to affect the early life stages of sturgeon or spawning habitat.

The water quality of the Kennebec River has improved over the past 30 years, but non-point sources of pollution, such as agricultural and highway run-off, persist. The effects of legacy pollutants from paper mills, CSOs, and other municipal and industrial sources continue to degrade the water quality in the action area, and the river in general.

5. CLIMATE CHANGE

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Climate change is relevant to the Status of the Species, Environmental Baseline, and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Consideration of effects of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the Effects of the Action section below (section 6.0 below).

5.1 Background Information on Global Climate Change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a). Precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). 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 other 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 2007b); these trends are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. For example, both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3^{o} -5^{o}C (5^{o} -9^{o}F) on average in the next 100 years, which is more than the projected global increase (NAST 2000). A warming of about 0.2^{o}C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). 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 resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

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 (Greene *et al.* 2008; IPCC 2006). 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 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). 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 (Greene *et al.* 2008; IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). 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 whole earth system (Greene *et al.* 2008).

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 Kennebec River, 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. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, 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 25 to 50 years, and it is possible that the rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through higher 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, which 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).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences 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). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat. 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 may 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 (0.4°F) 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 cm (6 - 8 inches).

5.2 Effects on Atlantic Salmon and Critical Habitat

Atlantic salmon may be especially vulnerable to the effects of climate change in New England, since the areas surrounding many watersheds s where salmon are found are heavily populated and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliott *et al.* 1998). Climate effects related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland 1998). One study conducted in the Connecticut and Penobscot rivers, where temperatures and average discharge rates have been increasing over the last 25 years, found that dates of first capture and median capture dates for Atlantic salmon have shifted earlier by about 0.5 days/ year, and these consistent shifts are correlated with long-term changes in temperature and flow (Juanes *et al.* 2004). 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 and this decline was best explained by climatic factors, like increasing summer temperatures and reduced discharge, more than any other factor (Clews *et al.* 2010). Changes in temperature and flow serve as cues for salmon to migrate, and smolts entering the ocean either too late or too early would then begin their post-smolt year in such a way that could be less optimal for opportunities to feed, predator risks, and/or thermal stress (Friedland 1998). Since the highest mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater *et al.* 2003). Temperature influences the length of egg incubation periods for salmonids (Elliott *et al.* 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

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

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). Post-smolt 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).

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

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

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

5.3 Effects on Shortnose Sturgeon and Atlantic Sturgeon

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

Rising sea level may result in the salt wedge moving upstream in affected rivers. Shortnose and Atlantic sturgeon spawning occurs in freshwater reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the salt wedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, for most spawning rivers there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the salt wedge. 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 select areas may increase runoff and scour spawning areas, and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with 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 select areas may cause loss of habitat, including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all sturgeon life stages, including adults, may become susceptible to stranding. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology, causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season, causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species.

5.4 Anticipated Effects of Climate Change in the Action Area

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Kennebec River watershed largely focus on effects that rising water levels may have on the human environment or landscape level changes (see UMass Assessment of Landscape Changes). Available information is summarized in Jacobson *et al*. 2009. This report indicates that for Maine, regional sea surface temperatures have increased almost 2° Fahrenheit since 1970 (as measured in Boothbay), and the rate of sea level rise has intensified. Tide-gauge records in Portland, Maine, show a local relative sea-level rise of approximately eight inches (20 cm) since 1912. Earlier snowmelt, peak river flows, and ice-out have been observed in Maine lakes. Models suggest that in the future, temperatures will be warmer and there will be more precipitation in all seasons. The effects of climate change will not increase appreciably during the proposed survey period. However, less snow may fall each winter and be replaced by rain. Additionally, increased rainfall will result in more runoff which in turn will likely reduce water quality in the action area.

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

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

Sea surface temperatures have fluctuated around a mean for much of the past century, as measured by continuous 100+ year records at Woods Hole (MA) and Boothbay Harbor (ME) and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing; for example, Boothbay Harbor's temperature has increased by about 1°C since 1970. For marine waters, the model projections are for an increase of somewhere between 3-4°C by 2100 and a pH drop of 0.3-0.4 units by 2100 (Frumhoff *et al.* 2007). Assuming that these predictions also apply to the action area, one could anticipate similar conditions in the action area over that same time period; considering that the proposed action will occur until 2019, we could predict an increase in ambient water temperatures of 0.034-0.045 per year, for an overall increase of 0.24^o - 0.32°C. As there is significant uncertainty in the rate and timing of change, as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose and Atlantic sturgeon and Atlantic salmon. However, the short time period over which the proposed actions will occur *(i.e.*, through November 2018) suggests that there are not likely to be major climate related changes experienced.

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

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

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon or salmon. If sturgeon or salmon 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 or salmon shifted to an area or time where insufficient forage was available; however, the likelihood of this happening seems low because sturgeon and salmon feed on a wide variety of species and in a wide variety of habitats.

Limited information on the thermal tolerances of Atlantic and shortnose sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (Damon-Randall *et al.* 2010); in the wild, shortnose sturgeon are typically found in waters less than 28°C (82.4°F). In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.* 2008; Jenkins *et al.* 1993); however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, have been documented in the lab to experience mortality at temperatures of 33.7°C (92.66°F) or greater and are thought to experience stress at temperatures above 28°C (82.4°F). For purposes of considering thermal tolerances, we consider Atlantic sturgeon to be a reasonable surrogate for shortnose sturgeon, given similar geographic distribution and known biological similarities.

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

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

6. EFFECTS OF THE ACTION

This section of the Opinion assesses the direct and indirect effects of the proposed action on endangered Atlantic salmon and its critical habitat, endangered Shortnose sturgeon, and threatened Atlantic sturgeon, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). We have not identified any interrelated or interdependent actions. As explained in the "Description of the Action" section above, the proposed action will involve electrofishing at eleven sites in the Kennebec River and three sites in the Sebasticook River. All sampling will occur during the standardized seasonal index period of July 1- September 30 (through October 15 in coastal rivers), during 2014-2018. This section of the Opinion analyzes the effects of the proposed sampling events on Atlantic salmon, Shortnose sturgeon, and Atlantic sturgeon present within the action area of this consultation.

6.1 Effects on Listed Species

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

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

Evidence to date strongly indicates that trout, char, and salmon (subfamily Salmoninae) are more

susceptible to spinal injuries, associated hemorrhages, and probably mortality during electrofishing than most other fishes (McMichael *et al*. 1998). Because voltage differential across fish or specific tissues increases with size, larger fish have been expected to be more susceptible to electrofishing mortality and injury than smaller fish. Some data support an increased frequency of spinal injuries as fish size increases, but other data do not, and so the importance of size remains questionable (Snyder 2004).
Based upon the best available data, Atlantic salmon, shortnose sturgeon, and/or Atlantic sturgeon could be present in any of the proposed sample sites in the Kennebec or Sebasticook Rivers. Due to the time of year when sampling will occur and the types of habitats that will be sampled, no spawning or overwintering fish will be affected; similarly, no salmon eggs or sturgeon eggs or other early life stages would be present in the action area during this time of year. Additionally, as all sampling will take place in deeper, non-wadeable habitats, no salmon parr would occur in the areas to be sampled. Also, no salmon smolts or early juvenile stage sturgeon will be present in the action area at the time of sampling. Therefore, the only Atlantic salmon likely to be exposed to effects of the action are adults, and the only shortnose sturgeon or Atlantic sturgeon likely to be exposed to effects of the action are adults or older subadults.

As evidenced by the counts of Atlantic salmon at the Lockwood fish lift (Table 3), the number of returning adults in the Kennebec River is greatest during the spring and early summer. From 2009 to 2013, only 15% (17 of 110) of returning salmon fish have used the Lockwood fishway during late summer and fall (August to October). Based on this information, we expect few Atlantic salmon to be present in the action area during the survey period. Nevertheless, as Atlantic salmon adults have been documented in the action area in September and October, it is reasonable to expect that Atlantic salmon will be encountered during electrofishing surveys. This is supported by data collected during prior bio-assessment studies conducted by MBI in the lower Kennebec and Sebasticook Rivers. From 2001–2012, MBI encountered a total of 10 Atlantic salmon during sampling. On August 12, 2002, two adult Atlantic salmon were encountered during electrofishing in Waterville. Both fish swam away unharmed. In July 2003, one young of the year Atlantic salmon was captured during electrofishing near the confluence of the Sebasticook and Kennebec Rivers. During the 2010 sampling season, an adult salmon was affected by electrofishing approximately 2.5 kilometers downstream of the Lockwood Dam in Waterville. In October 2011, five adult Atlantic salmon were encountered during sampling; three salmon in the Kennebec River near Waterville and two salmon in the Sebasticook River downstream of the Benton Falls Dam. Each of these fish also swam away unharmed by the encounter with electrofishing gear. It should be noted that the adult salmon returns in Maine were relatively high in 2011, thus explaining the relatively high number of salmon encountered during sampling; 64 adult Atlantic salmon were documented returning to the Kennebec River in 2011(*i.e.*, captured by MEDMR at the Lockwood Dam).

An Atlantic salmon was encountered on Sep. 25, 2012, approximately 100 meters downstream from the Lockwood Dam spillway near Winslow, ME; it swam away apparently unharmed. An Atlantic sturgeon was encountered the next day, Sep. 26, 2012, approximately 3.2 kilometers (≈ 2 miles) downstream; the individual vigorously swam away from the electrical field when the current was interrupted (MBI, unpublished report, 2012). A solitary Atlantic salmon was also encountered on Sep. 25, 2013, approximately 2.4 kilometers (1.5 miles) downstream from the confluence of the Sabasticook River; it too swam away apparently unharmed.

In the first of two August 2014 encounters with EPA's electrofishing gear, a 1.2 meter (4 ft.) long Atlantic sturgeon easily swam away from the electrical field when the current was interrupted (MBI, unpublished reports, 2014). In the second encounter, a 1.83 meter (6 ft.) long Atlantic sturgeon also swam away after the electrical field was interrupted. Neither fish was handled, netted, or showed signs of stress or physical injury that would have affected their ability to survive and resume normal behavior.

To estimate the number of salmon that may be encountered during the surveys, we considered a number of factors including:

- the seasonal distribution of Atlantic salmon in the Kennebec River watershed;
- the number of adult Atlantic salmon returning to the Kennebec River from 2006-2013;
- the number of Atlantic salmon captured at the Lockwood fish lift in September 2006-2013;
- the number of Atlantic salmon encountered during previous years of electrofishing supported surveys between Waterville and Augusta;
- the short duration of the study;
- the small number of areas being sampled (11 total); and,
- the relatively small effective range of the electrofishing boat.

Based on current trends and historic data collected over several years, we expect that no more than four adult Atlantic salmon will encounter the electric current associated with the electrofishing gear annually during the five-year study.

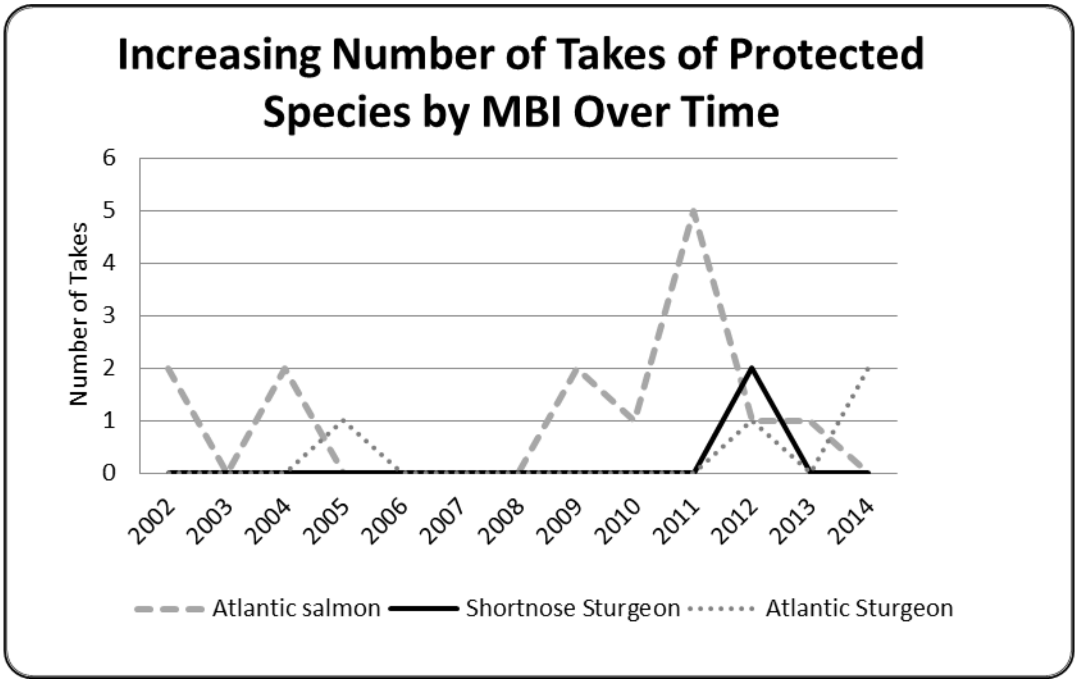
Similar factors were considered when estimating the number of Atlantic and/or shortnose sturgeon that may be encountered during electrofishing. While we do not have decades of data on adult returns on which to base our estimates, like there is for returning adult salmon, we do have information on the number of sturgeon encountered and relevant data collected by other researchers that suggest an increase in sturgeon population in the river, which indicates an increase in the potential for more encounters with sturgeon. With no estimate for the number of shortnose or Atlantic sturgeon in the action area, we must base our estimates on available information from previous encounters, other directed research, and overwintering aggregation estimates of shortnose sturgeon from MEDMR. Based on this information and considering sturgeon seasonal inter and intra-river movement and deep water habitat preference, we expect that no more than four adult or subadult Atlantic and four adult or subadult shortnose sturgeon will be exposed to the electric current associated with the electrofishing gear annually during the five-year study.

The electrofishing survey to be undertaken in the Kennebec River watershed will be performed pursuant to stream electrofishing protocols developed by the Maine Department of Inland Fisheries and Wildlife (ME DIFW) to minimize the potential for injury or mortality to listed species (Gallagher 2007). Mortality rates during electrofishing surveys carried out by MEDMR in the GOM DPS of Atlantic salmon have annually remained below 1% (MEDMR unpublished data). No injury or mortality of Atlantic salmon or Atlantic or shortnose sturgeon of any life stage is expected, as no listed juveniles are anticipated to occur in the action area, and the guidelines designed specifically to minimize the potential for injury or mortality will be followed.

Based upon this information, we conclude that of the four adult Atlantic salmon, four shortnose sturgeon, and four Atlantic sturgeon that may be exposed to the electrical current used during electrofishing activities annually during the survey, none are expected to experience mortality. Exposed fish may experience some stress and be temporarily stunned and may roll or twitch. It is also likely that any adult Atlantic salmon or Atlantic or shortnose sturgeon encountered during electrofishing will quickly recover and swim away. The available information indicates that these fish will likely recover within five minutes, if not immediately. No listed species will be handled or netted, thereby eliminating the risk of injury or long-term effects from those actions.

In summary, based on the limited size of the effective area of the electrofishing boat and the likely distribution of Atlantic salmon and Atlantic and shortnose sturgeon in the action area, no more than four Atlantic salmon, four shortnose sturgeon, and four Atlantic sturgon are expected to be affected annually during the five-year survey. Exposed fish may be temporarily stunned and exhibit rolling or twitching behavior, but no injuries or mortalities are expected, and any effects will be temporary. As no sampling will occur during spawning activities and any adults encountered during sampling will have time to recover prior to any subsequent spawning activities, no significant effects to spawning salmon or sturgeon are expected. It is important to note that the low number of expected encounters is supported by the available information from previous electrofishing surveys in the Kennebec River. As explained above and illustrated in figure 8 below, this survey has taken place for the past 13 years and only 14 anadromous Atlantic salmon and six sturgeon have been observed to have been exposed to the electrical field during electrofishing activities during that time.

Figure 8. Number of takes attributable to the MBI survey during its entire term.



Data Source: Chris Yoder, MBI. 2014

6.2 Effects on Designated Critical Habitat

The action area is a known migratory corridor 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 (PCEs) 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 project on designated critical habitat and PCEs in the action area. We have determined that the effects to these PCEs will be insignificant for the following reasons:

The project will not result in a migration barrier as the electrofishing operation will only affect a small portion of the river at any given time. Because the electrofishing boat has a small effective range, electric current, which could deter fish from passing through the affected area, will be experienced in an extremely small area of the river at any given time. Due to the limited range of the sampling gear, there is always a sufficient zone of passage past the electrofishing operation for any salmon moving past the area being sampled. The project will not alter the habitat in any way that would increase the risk of predation because the action will not interfere with the natural functioning of any sturgeon habitat, nor will the action have any long-term effect on the species' ability to detect and avoid any potential predators. Any effects to the water column will be limited to temporary electrification; there will be no other water quality impacts of the proposed action. The types of species that will be stunned by the electrofishing gear and be subject to capture by the researchers (e.g. smallmouth bass, white sucker, and American eel) are not likely to be the same species that juvenile or adult Atlantic salmon forage on (e.g. macro-invertebrates, rainbow smelt, and sea lamprey); therefore, the project will not significantly affect the forage of juvenile or adult Atlantic salmon.

Finally, as the action will not affect the natural structure of the nearshore habitat, there will be no reduction in the capacity of substrate, food resources, or natural cover to meet the conservation needs of Atlantic salmon. Based upon this reasoning, we have determined that any temporary short-term effects to designated critical habitat in the action area will be insignificant.

7. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR § 402.02 as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.

The future state and private activities that are reasonably certain to occur in the action area during the proposed action that may have effects on listed species are recreational and commercial fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

In December 1999, the State of Maine adopted regulations prohibiting all angling for sea-run salmon statewide. Despite strict state and federal regulations, adult Atlantic salmon remain vulnerable to injury and mortality due to incidental capture by recreational anglers and incidental catch in commercial fisheries. The best available information indicates that Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon are still incidentally caught by recreational anglers. Evidence suggests that Atlantic salmon are also targeted by poachers (NMFS 2005). Commercial fisheries for elvers (juvenile eels) and alewives may also capture Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon as bycatch. No estimate of the numbers of listed species caught incidentally in recreational or commercial fisheries in the action area exists.

Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Contaminants introduced into the water column or through the food chain eventually become associated with the benthos, where bottom dwelling and feeding species like shortnose and Atlantic sturgeon are particularly vulnerable. Atlantic salmon are also vulnerable to impacts from pollution and are also likely to continue to be impacted by water quality impairments in the GOM DPS.

Because the Sebasticook River watershed is primarily rural and dominated by small scale agriculture, silviculture, and standing forests, we do not anticipate any significant changes in land use that could potentially impact the action area. Along the Kennebec River, between Waterville and Augusta, the land use is also pastoral; however, there are more than 15 sand and gravel quarries along that reach of the river, some of which are within 30 meters of the river bank. Any expansion of the borrow pit operations could further degrade the riverine habitat and water quality of the Kennebec River action area.

As noted above, impacts to listed species from all of these activities are largely unknown. Further, we have no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

8. INTEGRATION AND SYNTHESIS OF EFFECTS

In the discussion below, we consider whether the effects of the proposed action 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 GOM DPS of Atlantic salmon, shortnose sturgeon, or the GOM and NYB DPSs of Atlantic sturgeon. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of the GOM DPS of Atlantic salmon, shortnose sturgeon, or the GOM and NYB DPSs of Atlantic sturgeon. In addition, the analysis will determine whether the proposed action will adversely modify designated critical habitat for Atlantic salmon.

In the NMFS/USFWS Endangered Species Consultation Handbook, 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 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." Jeopardize the continued existence of is defined in the regulations (50 CFR 402.02) as "an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 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." Therefore, to determine if the proposed action will jeopardize the GOM DPS of Atlantic salmon, shortnose sturgeon, GOM or NYB DPSs of Atlantic sturgeon, an analysis of the effects on survival and recovery must be conducted.

Below, for the GOM DPS of Atlantic salmon, shortnose sturgeon, and the GOM and NYB DPSs of Atlantic sturgeon, we summarize the status of the species and consider whether the proposed action will result in reductions in reproduction, numbers, or distribution of that species and then consider whether any reductions in reproduction, numbers, or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of the species, as those terms are defined for purposes of the ESA.

8.1 GOM DPS of Atlantic Salmon

GOM DPS Atlantic salmon currently exhibit critically low spawner abundance and poor marine survival and are confronted with a variety of additional threats. The abundance of GOM DPS Atlantic salmon has been low and declining over the past several decades. The proportion of fish that are of natural origin is extremely low (approximately 6% over the last ten years) and is continuing to decline. The conservation hatchery program assists in slowing the decline and helps 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 GOM DPS. Despite the threats faced by individual Atlantic salmon inside and outside of the action area, the proposed action will not increase the vulnerability of individual Atlantic salmon to these additional threats, and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action.

8.1.1 Summary of Sampling Effects

Since the precise locations of the electrofishing are known, we generally know whether GOM DPS Atlantic salmon will be present in the action area during the time at which the survey would be conducted; however, we do not know the density at which they may occur. Therefore, certain assumptions must be made based on the known distribution of salmon in the GOM DPS, as well as seasonal migratory patterns. Given their seasonal migratory patterns, salmon could be present in the action area during sampling periods at each site identified in Table 1, but may be found at a greater density in areas immediately downstream of dams.

Conducting in-stream activities associated with electrofishing could cause localized electrotaxis, *i.e.,* stun, twitch, or roll. These impacts are anticipated to be limited to a small footprint and short-term. Since we expect that all salmon that encounter the electrical current will fully recover within seconds, the proposed action is expected to have a very minor, extremely short-term negative impact on the GOM DPS of Atlantic salmon.

While individuals may be displaced from, or avoid, the electrified field,: (1) there will always be a zone of passage (> 50 meters); (2) any changes in movements would be limited to a few minutes to an hour where sampling would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health; and (5) any temporary minor changes in behavior resulting from exposure to electrical current associated with electrofishing will not preclude any GOM DPS Atlantic salmon from completing any essential behaviors such as resting, foraging, or migrating, or affect the fitness of any individuals.

8.1.2 Survival and Recovery Analysis for the GOM DPS of Atlantic Salmon

8.1.2.1 Survival Analysis

The first step in conducting this analysis is to assess the effects of the proposed project on the survival of the species. As noted above, survival is the ability to exist into the future with potential for recovery. Further, survival is predicated on a sufficient population of all necessary age classes, and of sexually mature individuals possessing genetic heterogeneity producing viable offspring which exist in an environment providing all requirements of the species' entire life cycle, including reproduction, sustenance, and shelter. There are three criteria that are evaluated under the survival analysis: reproduction, population numbers, and distribution.

- No Atlantic salmon of any life stage are expected to sustain injury from, or be killed by, electrofishing activities for the EPA survey; therefore, GOM DPS Atlantic salmon population numbers are not expected to be affected by the survey.
- Because the proposed action will occur in the late summer and early fall, spawning activities will not occur during the sampling periods, and therefore not be affected.
- Because the proposed surveys are discrete, ephemeral, and pose no barrier to natural migration or use of accessible habitat, we conclude that the proposed surveys will not alter or influence current salmon distribution.

As no salmon are to be handled or netted and no salmon are expected to be injured or die, we have determined that the proposed action will have a localized and short-term adverse effect on Atlantic salmon encountered during the term of the survey within the GOM DPS, but not appreciably reduce the likelihood that Atlantic salmon will survive in the wild.

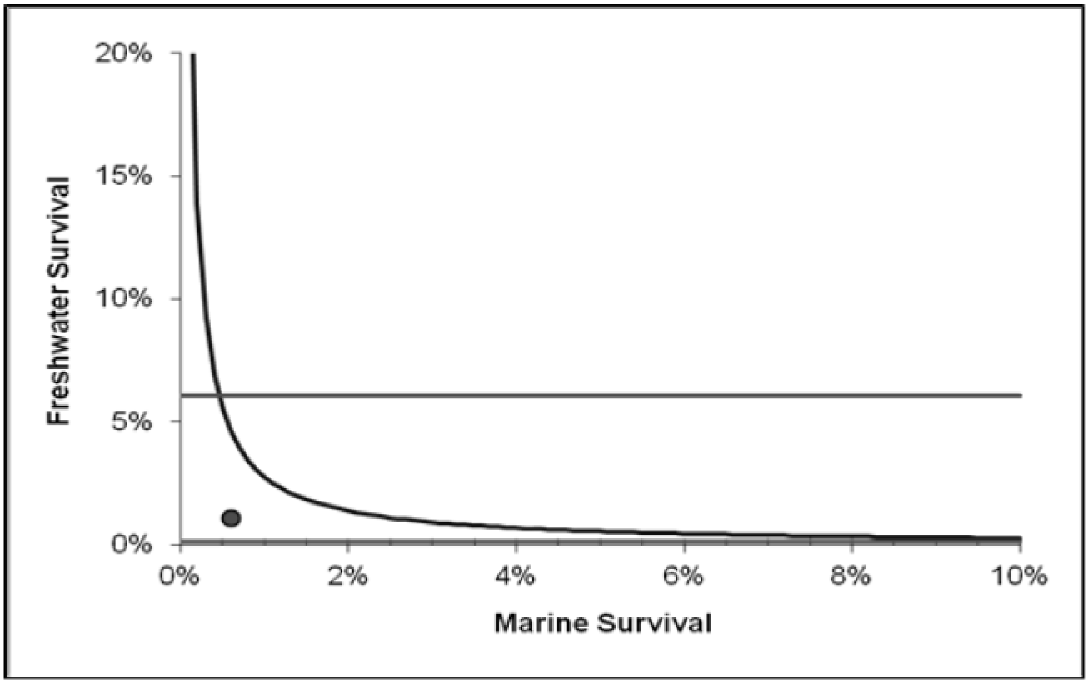
8.1.2.2 Recovery Analysis

The second step in conducting this analysis is to assess the effects of the proposed project on the recovery of the species. 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 ESA (50 CFR § 402.02). As with the survival analysis, there are three criteria that are evaluated under the recovery analysis: reproduction, population numbers, and distribution.

The recovery scenario incorporates baseline conditions, but does not include hatchery supplementation, as it is assumed that in a recovered population, stocking will not be necessary to sustain a viable population. In certain instances (e.g. Edwards Dam removal), 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 through expanding its range and/or increasing accessible habitat.

At existing freshwater and marine survival rates (the medians have been estimated by NMFS as 1.1% and 0.4%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. A significant increase in either one of these parameters (or a lesser increase in both) will be necessary to overcome the significant obstacles to recovery. We have created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (NMFS 2010). In Figure 9, the dot represents current marine and freshwater survival rates; the curved line represents all possible combinations of marine and freshwater survival rates that would result in a stable population with a growth rate of zero. If survival conditions are above the curved line, the population is growing, and, thus, trending towards recovery (lambda greater than one).

Figure 9. ASRT (2010) conceptual model depicting marine and freshwater survival relative to recovery of the GOM DPS of Atlantic salmon (Note: The dot represents current conditions, the curved line represents recovery, and the horizontal lines are the historic maximum and minimum freshwater survival).



The horizontal lines indicate the maximum and minimum rates of freshwater survival that have been historically observed (Legault 2004). This model indicates that there are many potential routes to recovery; for example, recovery could be achieved by significantly increasing the existing marine survival rate while holding freshwater survival at existing levels, or, conversely, by significantly increasing freshwater survival while holding marine survival at today's levels. Conceptually, however, the figure makes clear that an increase in both freshwater and marine survival will lead to the shortest and, therefore, most likely, path to achieving a self-sustaining population that is trending towards recovery.

In the mid-1980s to early 1990s there was a 50% to 70% decline in Atlantic salmon marine survival rates. This event is referred to as the regime shift (Chaput *et al.* 2005), the causes of which are unknown at this time (Windsor *et al.* 2012). Based on the smolt-to-adult return rate for wild fish in the Narraguagus River, USFWS (2012) estimated that the pre-regime shift marine survival rate ranged between 0.9% and 5.2%, with an average of 3.0%. A four-fold increase in the current median marine survival rate (from 0.4% to 1.7%) will allow for a rate that is within the range estimated to have existed prior to the regime shift.

Freshwater survival rates have historically ranged between 0.1% and 6.0%, with an average of 1.5% (Legault 2004). A two-fold increase in the existing median freshwater survival rate (from 1.1% to 2.2%) would create a condition that is above the historical mean, but is within the range that has been observed and, when coupled with improved marine survival, will allow for a modest positive growth rate in the Atlantic salmon population. Fortunately, there has been a change in this trend, which is supported by data collected from recent juvenile assessments that have shown an increase in large parr abundance across all SHRUs in response to hatchery stocking efforts (USASAC 2013).

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 this study would appreciably reduce the species' likelihood for recovery for the following reasons. First, there would be no measurable reduction in the number of returning adults and their reproductive success. Second, of the fish anticipated to be exposed to the electrical current, we anticipate no lasting effects on their ability to survive and reproduce. Lastly, since this survey has limited spatial and temporal coverage, any potential effects will be limited to a small number of sites on the Kennebec and Sebasticook Rivers during the periods of August 1 to October 15 in 2014-2018 and would not affect the species as a whole. Further, the information collected through these studies will be used to inform future management decisions that could potentially increase the likelihood for recovery. Therefore, the proposed action 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. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery of the species as a whole.

While we are not able to predict with precision how climate change will impact Atlantic salmon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to Atlantic salmon in the action area are anticipated over the term of this study. 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.

8.2 Critical Habitat for Atlantic Salmon

Destruction or adverse modification of critical habitat means "a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical." (50 CFR § 402.02).

Critical habitat for Atlantic salmon has been designated in the GOM DPS. As noted previously, within the action area of this consultation, the PCEs for Atlantic salmon are only those sites for (freshwater) migration. Conducting in-stream activities associated with electrofishing could create localized barriers to migration. Therefore, the electrofishing activities analyzed in this opinion will temporarily reduce the functioning of critical habitat in the immediate vicinity of the sampling. It is estimated that an average of one habitat unit per site (x 11 sites) will be temporarily impacted by the in-water work during electrofishing activities. These are very small, discrete, and temporary impacts to critical habitat that will temporarily degrade the functioning of the migratory PCE due to delays in migration.

Overall, designated critical habitat in the GOM DPS is anticipated to essentially remain unchanged with the implementation of the proposed survey. Since the action will not affect the natural structure of the existing habitat, change the temperature or dissolved oxygen, or alter the flow of water, there will be no reduction in the capacity of substrate, food resources, or natural cover to meet the conservation needs of listed Atlantic salmon. Therefore, the proposed project is not likely to adversely modify or destroy Atlantic salmon critical habitat.

8.3 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 km. 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 suggested by 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. The only river systems likely supporting populations close to expected abundance are the St John, Hudson, and possibly the Delaware and the Kennebec (Kynard 1996), 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 shortnose sturgeon population in the northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in populations for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, adds uncertainty to any determination on the status of this species as a whole. Based on the best available information, we believe that the status of shortnose sturgeon throughout their range is stable.

As described in the Status of the Species, Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the Kennebec and Sebasticook rivers are affected by habitat alteration, bycatch in recreational fisheries, water quality, and in-water construction activities. It is difficult to quantify the number of shortnose sturgeon that may be affected by anthropogenic sources in the Kennebec River each year. Through reporting requirements implemented under section 7 and section 10 of the ESA, for specific actions, we obtain some information on the number of incidental and directed takes of shortnose sturgeon each year. Typically, scientific research results in the capture and collection of less than 100 shortnose sturgeon in the Kennebec River each year, with little, if any, mortality. We have sporadic reports of interactions or mortalities of shortnose sturgeon in the Kennebec River resulting from dredging or other in-water construction activities. We have no quantifiable information on the effects of habitat alteration or water quality; in general, water quality has improved in the Kennebec River since the 1970s when the Clean Water Act (CWA) was implemented and log drives were terminated. We also have empirical evidence that shortnose sturgeon are expanding their range by undertaking coastal migrations into adjacent large rivers systems, such as the Penobscot and Merrimack, which suggests that the movement and distribution of shortnose sturgeon is not limited by habitat or water quality impairments (Fernandes *et al.* 2010; Zydlewski *et al.* 2011; Little *et al.* 2013). Despite ongoing threats, there is evidence that the Kennebec River population of shortnose sturgeon experienced significant growth between the 1970s and 1990s and that the population is now stable at high numbers (Squiers *et al.* 1982; Wipplehauser 2003; MEDMR 2003). Shortnose sturgeon in the Kennebec River continue to experience anthropogenic and natural sources of mortality. However, we are not aware of any future actions that are reasonably certain to occur that are likely to change this trend or reduce the stability of the Kennebec River population. Also, as discussed above, we do not expect shortnose sturgeon to experience any new effects associated with climate change during the proposed five-year study period. As such, we expect that numbers of shortnose sturgeon in the action area will continue to be stable at high levels over the duration of the proposed action.

8.3.1 Summary of Sampling Effects

Since the precise locations of the electrofishing are known, we generally know whether shortnose sturgeon will be present in the action area during the time at which the survey would be conducted; however, we do not know the density at which they may occur. Therefore, certain assumptions must be made based on the known temporal and spatial distribution of sturgeon in the Kennebec and Sebasticook Rivers. Given the species' current distribution, sturgeon could be present in the action area for each site identified in Table 1.

While individuals may be displaced from, or avoid, the electrified field,: (1) there will always be a zone of passage (> 50 meters); (2) any changes in movements would be limited to a few minutes to an hour, when sampling would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health; and, (5) any temporary minor changes in behavior resulting from exposure to electrical current associated with electrofishing will not preclude any shortnose sturgeon from completing any essential behaviors such as resting, foraging, or migrating, or affect the fitness of any individuals. Conducting in-stream activities associated with electrofishing could cause localized electrotaxis, *i.e.*, stun, twitch, or roll. These potential behavioral responses are expected to be spatially and temporally limited to the immediate area and exact time when electrofishing is conducted and, as such, will be limited to only a few hours per day, divided between 11 discrete locations. Since we expect all sturgeon that encounter the electrical current will fully recover within seconds, the proposed action is expected to have a very minor, extremely short-term, negative impact on shortnose sturgeon.

8.3.2 Survival and Recovery Analysis for Shortnose Sturgeon

8.3.2.1 Survival Analysis

No shortnose sturgeon of any life stage are expected to sustain injury from or be killed by electrofishing activities for the EPA survey; therefore, GOM DPS Atlantic sturgeon population numbers are not expected to be affected by the survey. As no sturgeon are to be handled or netted and no sturgeon are expected to be injured or die, we have determined that the proposed action will have a localized and short-term adverse effect on sturgeon in the surveyed rivers, but will not appreciably reduce the likelihood of shortnose sturgeon survival in the wild.

This action is expected to have an undetectable reduction in reproduction of shortnose sturgeon in the Kennebec or Sebasticook Rivers. While electrotaxis will result in behavioral changes for adults spawning in the action area (stun, twitch, roll), these changes are not expected to result in a reduction in the reproductive fitness of any adult and it would not result in a reduction in the number of spawning adults or the number of eggs or larvae produced in a given year because no spawning is anticipated in any portion of the river during the survey periods.

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 in the Kennebec and Sebasticook Rivers. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Any effects to distribution will be minor and temporary and limited to the temporal and spatial scale of the area affected by the electro-fishing operations.

Based on the information provided above, the exposure of shortnose sturgeon to the effects of MBI’s fish assemblage study (electro fishing) 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) the population trend of shortnose sturgeon in the Kennebec River is stable; (2) no mortality is expected; (3) there will be no long term effects to the fitness of any individuals and no effect on reproductive output of the Kennebec River population of shortnose sturgeon or the species as a whole; (4) and, the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area (related to movements around the electrified area) and no effect on the distribution of the species throughout its range.

8.3.2.2 Recovery Analysis

This action is expected to have an undetectable reduction in reproduction of shortnose sturgeon in the Kennebec River because, while it will result in behavioral changes for adults spawning in the action area (stun, twitch, roll), these changes are not expected to result in a reduction in the reproductive fitness of any adult and it would not result in a reduction in the number of spawning adults or the number of eggs or larvae produced in a given year because no spawning is anticipated in any portion of the river during the survey periods.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in no reduction in the number of shortnose sturgeon in the Kennebec River and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, there is not expected to affect the persistence of the Kennebec River population of shortnose sturgeon or the species as a whole. There will not be a change in the status or trend of the Kennebec River population, which is stable at high numbers. As it will not affect the status or trend of this population, it will not affect the status or trend of the species as a whole. As there will be no reduction in numbers or future reproduction, the action would not cause any reduction in the likelihood of improvement in the status of shortnose sturgeon throughout their range. The effects of the proposed action will not delay the recovery timeframe or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species as a whole. The effects of the proposed action 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 action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species

8.4 Gulf of Maine DPS of Atlantic Sturgeon

Individuals originating from the GOM DPS are likely to occur in the action area. The GOM DPS has been listed as threatened. While Atlantic sturgeon occur in several rivers in the GOM DPS, recent spawning has only been documented in the Kennebec and Androscoggin rivers. No population estimates are available; the ASSRT estimated that there were fewer than 300 adults spawning in the DPS each 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.

8.4.1 Summary of Sampling Effects

Since the precise locations of the electrofishing are known, we generally know whether Atlantic sturgeon will be present in the action area during the time at which the survey would be conducted; however, we do not know the density at which they may occur. Therefore, certain assumptions must be made based on the known temporal and spatial distribution of sturgeon in the Kennebec and Sebasticook Rivers. Given the species' current distribution, sturgeon could be present in the action area for each site identified in Table 1.

While individuals may be displaced from, or avoid, the electrified field: (1) there will always be a zone of passage (> 50 meters); (2) any changes in movements would be limited to a few minutes to an hour where sampling would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health; and (5) any temporary minor changes in behavior resulting from exposure to electrical current associated with electrofishing will not preclude any Atlantic sturgeon from completing any essential behaviors such as resting, foraging, or migrating, or affect the fitness of any individuals. Conducting in-stream activities associated with electrofishing could cause localized electrotaxis, *i.e.*, stun, twitch, or roll. These potential behavioral responses are expected to be spatially and temporally limited to the immediate area and exact time when electrofishing is conducted, and as such, will be limited to only a few hours per day at one of 11 discrete locations. Since the action will not affect the natural structure of the existing habitat, change the temperature or dissolved oxygen or alter the flow of water, there will be no reduction in the capacity of substrate, food resources, and natural cover to meet the conservation needs of listed Atlantic sturgeon. Since we expect all sturgeon that encounter the electrical current will fully recover within seconds, the proposed action is expected to have a very minor, extremely short-term negative impact on Atlantic sturgeon.

8.4.2 Survival and Recovery Analysis for GOM DPS of Atlantic Sturgeon

8.4.2.1 Survival Analysis

No GOM DPS Atlantic sturgeon of any life stage are expected to sustain injury from or be killed by electrofishing activities for the EPA survey; therefore, GOM DPS Atlantic sturgeon numbers are not expected to be affected by the survey. As no sturgeon are to be handled or netted and no sturgeon are expected to be injured or die, we have determined that the proposed action will have a localized and short-term adverse effect on sturgeon in the surveyed rivers, but will not appreciably reduce the likelihood of Atlantic sturgeon survival in the wild.

This action is expected to have an undetectable reduction in reproduction of GOM DPS Atlantic sturgeon in the Kennebec River because, while it will result in behavioral changes for adults spawning in the action area (stun, twitch, roll), these changes are not expected to result in a reduction in the reproductive fitness of any adult. The action would not result in a reduction in the number of spawning adults or the number of eggs or larvae produced in a given year, because no spawning is anticipated in any portion of the river during the survey periods.

The proposed action is not likely to reduce distribution, because the action will not impede GOM DPS Atlantic sturgeon from accessing any seasonal concentration areas, including foraging or spawning grounds in the Kennebec and/or Sebasticook Rivers. Further, the action is 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 temporal and spatial scale of the area affected by the electrofishing operations.

Based on the information provided above, the exposure of GOM DPS Atlantic sturgeon to MBI's fish assemblage study (electrofishing) 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) the population trend of Atlantic sturgeon in the Kennebec River is stable; (2) no mortality is expected; (3) there will be no long-term effects to the fitness of any individuals and no effect on reproductive output of the Kennebec River population of Atlantic sturgeon or the species as a whole; and(4) the action will have only a minor and temporary effect on the distribution of Atlantic sturgeon in the action area (related to movements around the electrified area) and no effect on the distribution of the species throughout its range.

8.4.2.2 Recovery Analysis

In rare instances, it may be determined that an action does not appreciably reduce the likelihood of a species' survival, but that same action might affect the species' 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 Atlantic 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)(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 action is not expected to modify, curtail, or destroy the range of the species, since it will result in no reduction in the number of Atlantic sturgeon in the Kennebec River and will not affect the overall distribution of Atlantic sturgeon, other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize Atlantic sturgeon for recreational, scientific, or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output, and therefore, is not expected to affect the persistence of the Kennebec River population of Atlantic sturgeon or the species as a whole. There will not be a change in the status or trend of the Kennebec River population, which is stable at high numbers. As the proposed action will not affect the status or trend of this population, it will not affect the status or trend of the species as a whole. As there will be no reduction in numbers or future reproduction, the action would not cause any reduction in the likelihood of improvement in the status of Atlantic sturgeon throughout their range. The effects of the proposed action will not delay the recovery timeframe or otherwise decrease the likelihood of recovery, since the action will not cause any mortality or reduction of overall reproductive fitness for the species as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can be brought to the point at which it is no longer listed as threatened. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival or recovery of this species.

8.5 New York Bight DPS of Atlantic Sturgeon

The NYB DPS of Atlantic sturgeon has been listed as endangered. While Atlantic sturgeon occur in several rivers in the NYB DPS, recent spawning has only been documented in the Delaware and Hudson rivers. As noted above, we expect approximately 6% of the Atlantic sturgeon in the action area to come from the New York Bight DPS, and all of those fish would likely originate from the Hudson River (Damon-Randall *et al.* 2012).

There is limited information on the demographics of the Hudson River population of Atlantic sturgeon. 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). 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 6 year classes, excluding young of year.

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. Mixed stock analysis from the NMFS NEFOP indicates that 49% of these individuals are likely to originate from the NYB and 91% of those likely originate from the Hudson River, for a total of approximately 167 adult and subadult mortalities annually. 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. Additional sources of potential mortality include vessel strikes and entrainment in dredges.

8.5.1 Summary of Sampling Effects

The effects of electrofishing to the NYB DPS of Atlantic sturgeon are consistent with those outlined above for the GOM DPS of Atlantic sturgeon. That is, no injury or mortality is anticipated.

8.5.2 Survival and Recovery Analysis for NYB DPS of Atlantic Sturgeon

8.5.2.1 Survival Analysis

No NYB DPS Atlantic sturgeon of any life stage are expected to sustain injury from or be killed by electrofishing activities for the EPA survey; therefore, NYB DPS Atlantic sturgeon are not expected to be affected by the survey. As no NYB DPS Atlantic sturgeon are to be handled or netted and no sturgeon are expected to be injured or die, we have determined that the proposed action will have a localized and short-term adverse effect on NYB DPS Atlantic sturgeon in the surveyed rivers, but will not appreciably reduce the likelihood of NYB DPS Atlantic sturgeon survival in the wild.

This action is expected to have an undetectable reduction in reproduction of NYB DPS Atlantic sturgeon because no spawning by the NYB DPS of Atlantic sturgeon occurs in the action area. The proposed electrofishing will not result in a reduction in the number of spawning adults from the NYB DPS or the number of eggs or larvae produced in a given year because spawning for the NYB DPS of Atlantic sturgeon is only known to occur in the Hudson and Delaware rivers. Further, the action will not create any barrier to pre-spawning sturgeon migration or accessing distant spawning grounds.

The proposed action is not likely to reduce distribution, because the action will not impede NYB DPS Atlantic sturgeon from accessing any seasonal concentration areas, including foraging or spawning grounds in the Kennebec River or elsewhere. Any effects to distribution will be minor and temporary and limited to the temporal and spatial scale of the area affected by the electrofishing operations.

Based on the information provided above, the exposure of NYB DPS Atlantic sturgeon to MBI’s fish assessment study 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 NYB DPS Atlantic sturgeon; (2) there will be no effect on the fitness of any individuals and no effect on reproductive output of the NYB DPS of Atlantic sturgeon; and (3) the action will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area (related to movements around the electrified area) and no effect on the distribution of the species throughout its range.

8.5.2.2 Recovery Analysis

As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the NYB DPS will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery, as we did for the GOM DPS.

The proposed action is not expected to modify, curtail, or destroy the range of the species, since it will result in no reduction in the number of NYB DPS Atlantic sturgeon and will not affect the overall distribution of NYB DPS Atlantic sturgeon other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize NYB DPS Atlantic sturgeon for recreational, scientific, or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output, and therefore, is not expected to affect the persistence of the NYB DPS of Atlantic sturgeon. There will not be a change in the status or trend of the NYB DPS of Atlantic sturgeon. As there will be no reduction in numbers or future reproduction, the proposed action would not cause any reduction in the likelihood of improvement in the status of the NYB DPS of Atlantic sturgeon. The effects of the proposed action will not shorten the recovery timeframe or otherwise decrease the likelihood of recovery, since the action will not cause any mortality or reduction of overall reproductive fitness for the species. Therefore, the proposed action will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can be brought to the point at which it is no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival or recovery of this species.

9. CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under our jurisdiction in the Kennebec and Sebasticook Rivers, the environmental baseline of the action area, the effects of the action, and the cumulative effects, it is our biological opinion that the proposed action may adversely affect, but is not likely to jeopardize the continued existence of shortnose sturgeon, Gulf of Maine Distinct Population Segment of Atlantic sturgeon, New York Bight Distinct Population Segment of Atlantic sturgeon, or Gulf of Maine Distinct Population Segment of Atlantic salmon. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of designated Atlantic salmon critical habitat.

10. 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. 16 U.S.C. 1532(19)). Harm is further defined by NMFS to mean an act which actually kills or injures fish or wildlife. Such 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. 50 CFR 222.102. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 50 CFR 402.02. "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. ESA 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 United States, including an individual, corporation, officer, employee, department or instrument of the Federal government. 16 U.S.C. 1532(13)). Under the terms of ESA 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 Incidental Take Statement. In issuing this ITS, NMFS takes no position on whether the action is an "otherwise lawful activity."

10.1 Amount or Extent of Incidental Take

This ITS serves two important functions: (1) it provides an exemption from the Section 9 prohibitions for any taking incidental to the proposed action that is in compliance with the terms and conditions; and (2) it provides the means to insure the action as it is carried out is not jeopardizing the continued existence of affected species by monitoring and reporting the progress of the action and its impact on the species such that consultation can be reinitiated if any of the criteria in 50 CFR 402.16 are met.

10.1.1 Incidental Take of Atlantic Salmon

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

The removal of the Edwards Dam has allowed GOM DPS Atlantic salmon to migrate further upstream and re-utilize habitat that has been inaccessible for over 150 years; EPA's take during prior years' surveys has reflected the increasing number of Atlantic salmon in the action area. Due to the timing of the proposed study in relation to the timing of the adult run, it is anticipated that an extremely small proportion of the total annual run could still be migrating upstream in the Kennebec and Sebasticook rivers at the time that electrofishing activities are underway. Considering that the upstream extent of two of the 11 proposed action areas are delineated by the Lockwood and Benton Falls Dams, the probability of salmon encounters increases because of the increase in population density of salmon that is likely to occur at the base of the dams due to the delay in migration. However, given the 2014 adult returns to the Kennebec and Sebasticook Rivers (16 and 2 respectively), the likelihood of an adult being present at any given site is extremely small.

Based on available population estimates, the known distribution of the species within the action area, the location of the sampling sites, and the effective range of the electrofishing unit, we have determined that no more than four adult Atlantic salmon from the GOM DPS are likely to be affected annually by the five-year electrofishing survey. While no injuries or mortalities to any Atlantic salmon are expected, the anticipated interaction of four GOM DPS Atlantic salmon with sampling gear (exposure to the electric field) would be considered harassment under section 9 of the ESA. In the accompanying biological opinion, we have determined that this level of anticipated take is not likely to result in jeopardy to the species.

10.1.2 Incidental Take of Shortnose Sturgeon

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

In the past, shortnose sturgeon have generally spent summer months foraging lower in the watershed and moved upstream towards overwintering areas in the fall. The removal of the Edwards Dam has allowed shortnose sturgeon to occupy habitat that has been inaccessible for over 150 years; EPA's take during prior years' surveys has reflected the increasing number of shortnose sturgeon in the action area. As the downstream extent of sampling is upstream of historic overwintering sites, we would not expect to encounter shortnose sturgeon in the action area. However, as EPA's recent sampling has shown (2012), shortnose sturgeon may be present in the action area during electrofishing activities.

Based on available population estimates, the known distribution of the species within the action area, the location of the sampling sites, and the effective range of the electrofishing unit, we have determined that no more than four individual shortnose sturgeon are likely to be effected annually by the five-year electrofishing survey. While no injuries or mortalities to any listed species are expected, the anticipated interaction of a shortnose sturgeon with sampling gear would be considered harassment under section 9 of the ESA. In the accompanying biological opinion, we have determined that this level of anticipated take is not likely to result in jeopardy to the species.

10.1.3 Incidental Take of Atlantic Sturgeon

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

Based on DPS composition in the action area, available population estimates, the known distribution of the species within the action area, the location of the sampling sites, and the effective range of the electrofishing unit, we have determined that no more than four Atlantic sturgeon from either the GOM or NYB DPS are likely to be effected annually by the five-year electrofishing survey. While no injuries or mortalities to any listed sturgeon are expected, the anticipated interaction of a sturgeon with sampling gear would be considered harassment under section 9 of the ESA. In the accompanying biological opinion, we have determined that this level of anticipated take is not likely to result in jeopardy to the species.

10.2 Reasonable and Prudent Measures

Reasonable and prudent measures are those measures necessary and appropriate to minimize incidental take of a listed species. We believe the following reasonable and prudent measures are necessary and appropriate to minimize and monitor impacts of incidental take of Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon:

1. EPA must ensure that the contractor contact our NERO Protected Resources Division before sampling commences and again upon completion of the sampling activity.
2. EPA must ensure that personnel electrofishing have appropriate training in electrofishing and be trained in the identification of listed species.
3. EPA must ensure that all electrofishing procedures are designed to minimize the potential for injury or mortality of listed species.
4. EPA must ensure that the contractor promptly report all interactions with listed species to our Protected Resources Division.

10.3 Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, EPA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and which outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. These terms and conditions must be included as part of the contractual and assistance agreements between EPA and MBI and their subcontractors.

1. To implement RPM #1, EPA must contact us within 48 hours of beginning and ending sampling (Max Tritt: by email (max.tritt@noaa.gov) or phone (207-866-3756)).

2. To implement RPM #2, personnel shall be trained in listed species identification and MEDMR electrofishing protocols.

3. To implement RPM #2, EPA must contact us within 24 hours of any interactions with any listed fish species, including non-lethal and lethal takes (Max Tritt: by email (max.tritt@noaa.gov) or phone (207-866-3756)), and report via email to incidental.take@noaa.gov.

4. To implement RPM #3, EPA must instruct the contractor to not net or handle any listed species.

5. To implement RPM #4, EPA must instruct the contractor that in the event listed species come in contact with sampling gear, all electrofishing must cease for 5 minutes or until the fish is observed to recover and leaves the sampling area (whichever is longer).

6. To implement RPM #4, in the event of any observation or interaction with a listed species, an incident report form (Appendix A) must be completed and submitted to us within 24 hours via email to incidental.take@noaa.gov.

7. To implement RPM #4, in the event of any lethal take of Atlantic salmon, shortnose sturgeon, or Atlantic sturgeon, any dead specimens or body parts must be photographed, and immediately preserved (refrigerated or frozen) until disposal procedures are discussed with us.

8. To implement RPM #4, the EPA must submit a final report at the end of each calendar year summarizing the results of sampling activities and any takes of listed species to us by mail to the attention of the Max Tritt, 17 Godfrey Drive, Suite 1, Orono, ME 04473, and to the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep us informed of when sampling activities are taking place and will require EPA to report any take in a reasonable amount of time, as well as avoid additional sources of injury and mortality to adult fish that may result from handling associated with netting. Terms and Conditions 1, 2, 3, 5, 6, 7, and 8 are specifically designed to monitor take. Term and Condition 2 will insure that any listed species are accurately identified so as to appropriately monitor take. As listed species may be vulnerable to additional injury and/or mortality if handled or captured in a handheld net, Term and Condition 4 is necessary and appropriate to prevent the occurrence of this additional source of injury and mortality. Term and Condition 5 will further reduce any impacts to listed species by allowing any stunned individuals interacting with sampling gear to recover and move outside of the sampling area. Although we do not anticipate any lethal take, the implementation of Term and Condition 7 is necessary and appropriate to preserve any dead Atlantic salmon, shortnose sturgeon, or Atlantic sturgeon so that they may be salvaged and examined to determine the cause of death. Genetic information is also important in determining, when possible, whether the salmon was naturally reared or hatchery origin. Term and Condition 8 is required to complete the annual take reporting requirement.

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. We have determined that the proposed action is not likely to jeopardize the continued existence of endangered Atlantic salmon or shortnose sturgeon or threatened Atlantic sturgeon. To further reduce the adverse effects of fisheries sampling on listed species, we recommend that EPA implement the following conservation recommendation:

1. If any lethal take occurs, the EPA should arrange for contaminant analysis of the specimen. If this recommendation is to be implemented, the fish should be immediately frozen and we should be contacted within 24 hours to provide instructions on shipping and preparation.

12. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposal by the EPA to fund an electrofishing survey in the lower Kennebec and Sebasticook rivers. 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 taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

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APPENDIX A.

Incidental Take Report: Kennebec & Sebasticook River Fish Assemblage Study

Photographs should be taken and the following information should be collected from all salmon or sturgeon (alive and dead) found in association with the bridge replacement. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name: ____
Reporter's full name: ____

Species Identification:____________________________________

Describe construction activities ongoing within 24 hours of observation:
____
____

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 fish and how it was documented (e.g., observer on boat):
____

Species Information:
Species _____________________________

Fork length (or total length) __________________ Weight ___________________

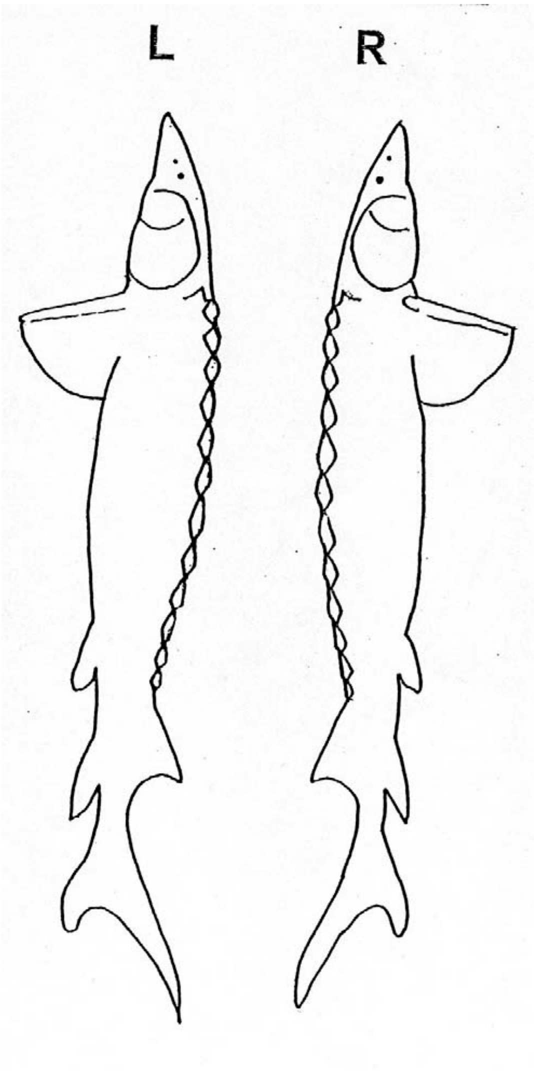
Condition of specimen/description of animal
____
____
____
____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish tagged: YES / NO Please *record all tag numbers.* Tag # ______________

Photograph attached: YES / NO
(Please label *species*, *date*, *geographic site* and *vessel name* on back of photograph)

Appendix A. Continued

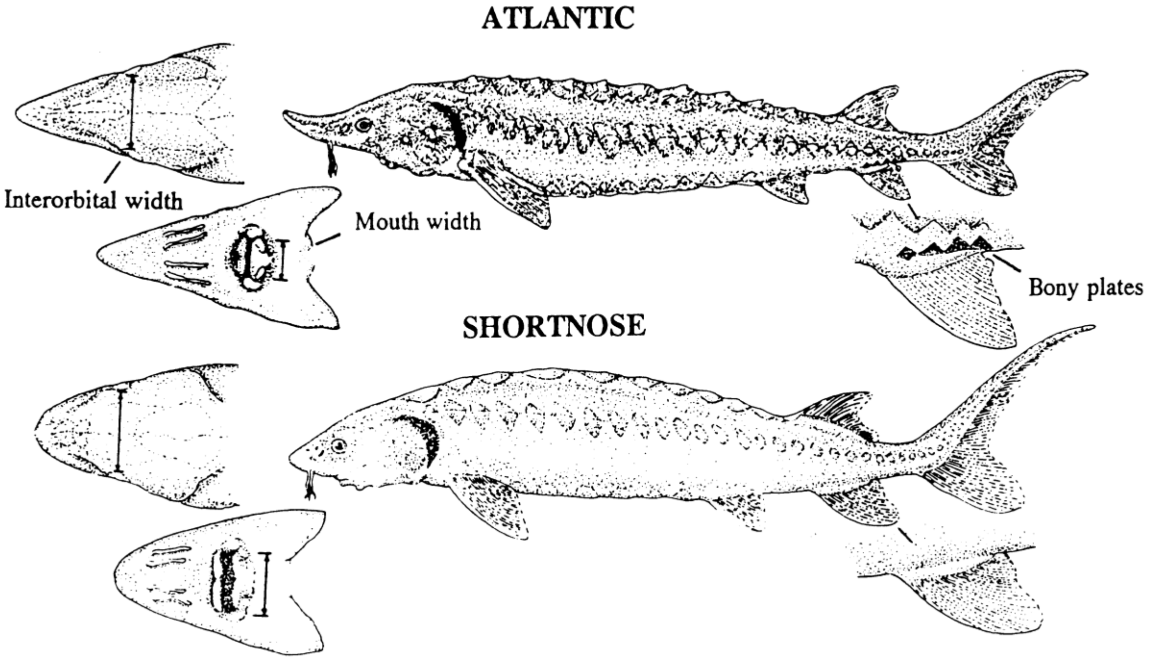
Draw wounds, abnormalities, tag locations on diagram and briefly describe below



Description of fish condition:

Appendix A. Continued

Identification Key for Sturgeon Found in Northeast U.S. Waters



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

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* From Vecsei and Peterson, 2004