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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-2013-10022

Conducted by: National Marine Fisheries Service
Northeast Region

Date Issued: SEP 24 2013

Approved by: [signature]

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1. ***INTRODUCTION AND BACKGROUND***

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) on the effects of the US Environmental Protection Agency's (EPA) proposed funding of a multi-year bioassessment 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*.). The proposed action entails funding the Midwest Biodiversity Institute's (MBI) conduct of an electrofishing survey the in lower Kennebec River and Sebasticook River in Maine during 2013 - 2017. 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 GOM DPS, and/or, New York Bight (NYB) DPS. The Kennebec River sampling sites also occur within designated critical habitat for the GOM DPS of Atlantic salmon.

This Opinion is based on the information provided in the EPA's original 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, and 2012 also factor into 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' biological assessments. The most recent formal consultation on this action was completed on September 19, 2012. The consultation covered a 5 year sampling period from 2012 – 2016. This consultation will also cover a five the period from 2013 through 2017. Re-initiation of formal consultation is required because MBI exceeded their sturgeon take limit within the first year of sampling. Re-initiation of formal consultation commenced on 6 August 2013. A complete administrative record of this consultation will be kept at our Main Field Office in Orono, Maine.

1.1 Consultation History

- ***April 1, 2009*** - EPA requested formal consultation with us on the effects of their proposed bioassessment 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 previous encounters with listed species, we exempted the non-lethal taking of two Atlantic salmon during 2010 assessments. No listed species were encountered 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 previous encounters with listed species, we exempted the non-lethal taking of two Atlantic salmon during 2011 assessments. Four 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 expected higher number of Atlantic salmon in the Kennebec River in 2012, the EPA requested an increase in exempted take from two salmon to six salmon;
- ***June 21, 2012*** - We acknowledged that adequate information to proceed with formal consultation;
- ***July 2, 2012*** - Representatives from the EPA, MBI, and NMFS discussed the likelihood of the survey to continue 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 bioassessment survey;
- ***September 19, 2012*** - We issued an updated Opinion concerning EPA's proposed studies on the Kennebec River. The consultation covered the 5 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 5 year period;
- ***September 26, 2012*** **–** EPA advised us of a non-lethal taking of an Atlantic sturgeon.
- ***October 11, 2012*** **–** EPA advised us of a non-lethal taking a shortnose sturgeon;
- ***August 2, 2013*** - EPA requested re-initiation of formal consultation with us on the effects of their proposed bioassessment project in the Kennebec River watershed, Maine;
- ***August 6, 2013*** – Re-initiation 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 is the exceedance of authorized sturgeon take, and your request for re-initiation of formal consultation, dated August 2, 2013.

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 your 2012 sampling sessions.

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

This section describes the approach used in this Opinion in order 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 by 50 CFR §402.02 (the consultation regulations). Additional guidance for this analysis is provided by the Endangered Species Consultation Handbook, March 1998, issued jointly by us and the USFWS. In conducting analyses of actions under section 7 of the ESA, we take the following steps, as directed by the consultation regulations:

- Identifies the action area based on the action agency's description of the proposed action (Section 2);
- Evaluates the current status of the species with respect to biological requirements indicative of survival and recovery and the essential features of any designated critical habitat (Section 3);
- Evaluates 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);
- Evaluates the relevance of climate change on environmental baseline and status of the species (Section 5);
- Determines 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);
- Determines and evaluates any cumulative effects within the action area (Section 7); and
- Evaluates 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 is 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 ESA-listed species or result in the destruction or adverse modification of designated critical habitat. If so, we must identify a reasonable and prudent alternative(s) (RPA) to the action as proposed that avoids jeopardy or adverse modification of critical habitat and meets the other regulatory requirements for an RPA (see 50 CFR §402.02). In making these determinations, we must rely on the best available scientific and commercial data. Conservation recommendations that are discretionary agency activities can also be suggested in order 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 (Gifford Pinchot Task Force *et al.* v. U.S. Fish and Wildlife Service, No. 03-35279, August 6, 2004).

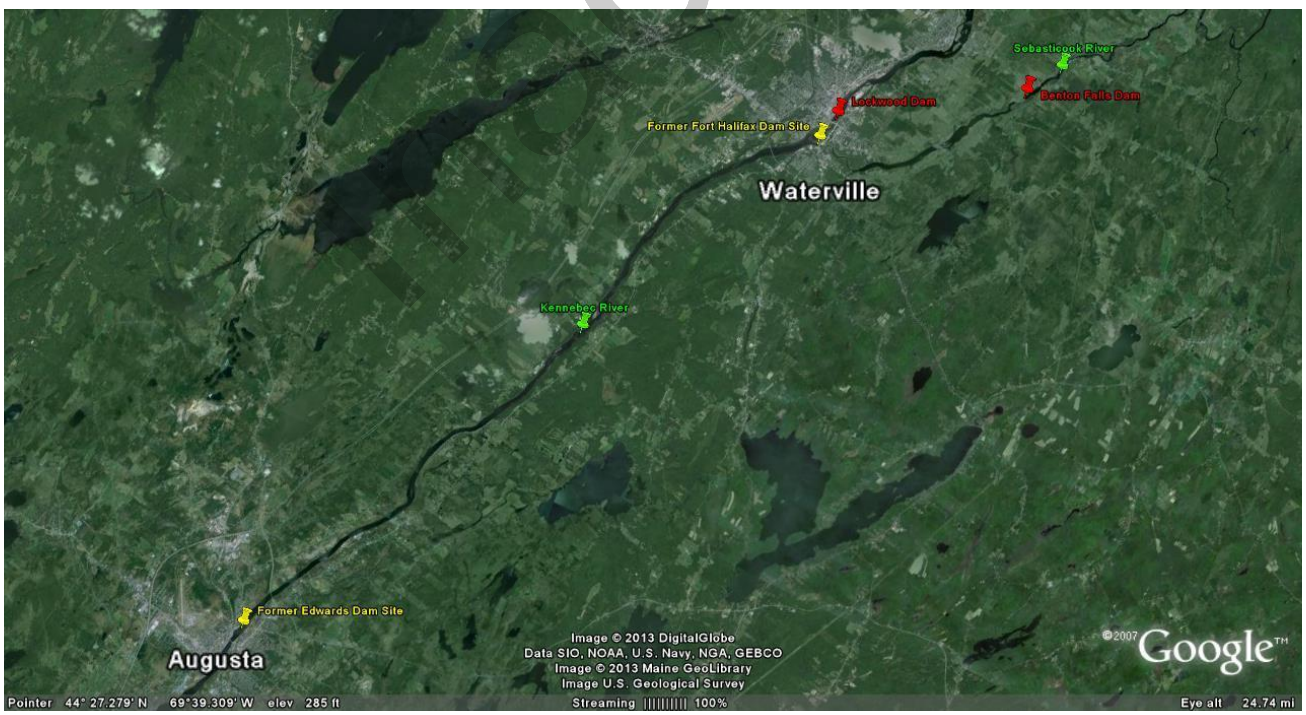
2. DESCRIPTION OF THE PROPOSED ACTION

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 begin in the fall of 2013 and continue through 2017. The project includes a fish assemblage survey based on a single gear electrofishing methodology. 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)

Figure 1. Map of survey area and significant landmarks.



The 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.* (2006a; *i.e.,*"the 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. IBI type sampling occurs 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).

2.2 Electrofishing Methodology

Electrofishing entails passing an electric current through the water to capture or control fish. The electric current cause 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 held for each fish will vary; however, as fish are processed after each transect the maximum holding time for any one fish will be 90 minutes. Captured fish will be identified to species, measured, 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 is not invariable. Sampling distance is determined with a GPS unit and/or laser range finder.

2.3 Sampling Procedure

A boat-rigged, pulsed D.C. 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 Smith-Root 2.5 or 5.0 GPP alternator-pulsator that produces up to 1000 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 µS/cm2 and the low range is used at higher conductivities up to 1200 µS/cm2. 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) which are suspended from the bow and two-three gangs of anodes (positive polarity) suspended from a retractable aluminum boom, the number used being dependent on the conductivity of the water. 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- foot 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 at low conductivity (three gangs) 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. These are powered by the 12-volt DC output of the 5.0 GPP generator. Auxiliary lighting includes headlamps worn by the sampling crew and hand held lamps of 500,000 to 1,000,000 candle power. A 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 legitimately 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, this 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. Special handling procedures are employed for certain species. For example, adult Atlantic salmon or sturgeon would not be netted when sighted and the electric current would be turned off upon observation of these species. Any size estimates would be made visually. 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, weighed and, if necessary, measured for total length. Every effort is made to minimize holding and handling times. Non-indigenous species may be kept and appropriately disposed of out of the water per the request of the state management agencies. The majority of captured fish are identified to species in the field; however, any uncertainty about the field identification of individual fish requires their preservation for later laboratory identification. Fish are preserved for future identification in borax buffered 10% formalin and labeled by date, river or stream, and geographic identifier (e.g., river mile). 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 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. Samples that are comprised of two or more distinct size classes of fish (e.g., y-o-y, juveniles, and adults) are processed separately.

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 and based on the susceptibility of each 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, 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 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 Rivers. 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.

3. STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

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

This section focuses on the status of the listed species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

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 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 decision to expand the range of the GOM DPS was largely based on the results of a Status Review (Fay *et al.* 2006) completed by a Biological Review Team consisting of Federal and State agencies and Tribal interests. Fay *et al.* (2006)

conclude that the DPS delineation in the 2000 listing designation was largely appropriate, except in the case of large rivers that were partially or wholly excluded in the 2000 listing determination. Fay *et al.* (2006) conclude that the salmon currently inhabiting the larger rivers (Androscoggin, Kennebec, and Penobscot) are genetically similar to the rivers included in the GOM DPS as listed in 2000, have similar life history characteristics, and occur in the same zoogeographic region. Further, the salmon populations inhabiting the large and small rivers from the Androscoggin River northward to the Dennys River differ genetically and in important life history characteristics from Atlantic salmon in adjacent portions of Canada (Spidle *et al.* 2003; Fay *et al.* 2006). Thus, Fay *et al.* (2006) conclude that this group of populations (a "distinct population segment") met both the discreteness and significance criteria of the Services' DPS Policy (61 FR 4722; February 7, 1996) and, therefore, recommend the geographic range included in the new expanded GOM DPS.

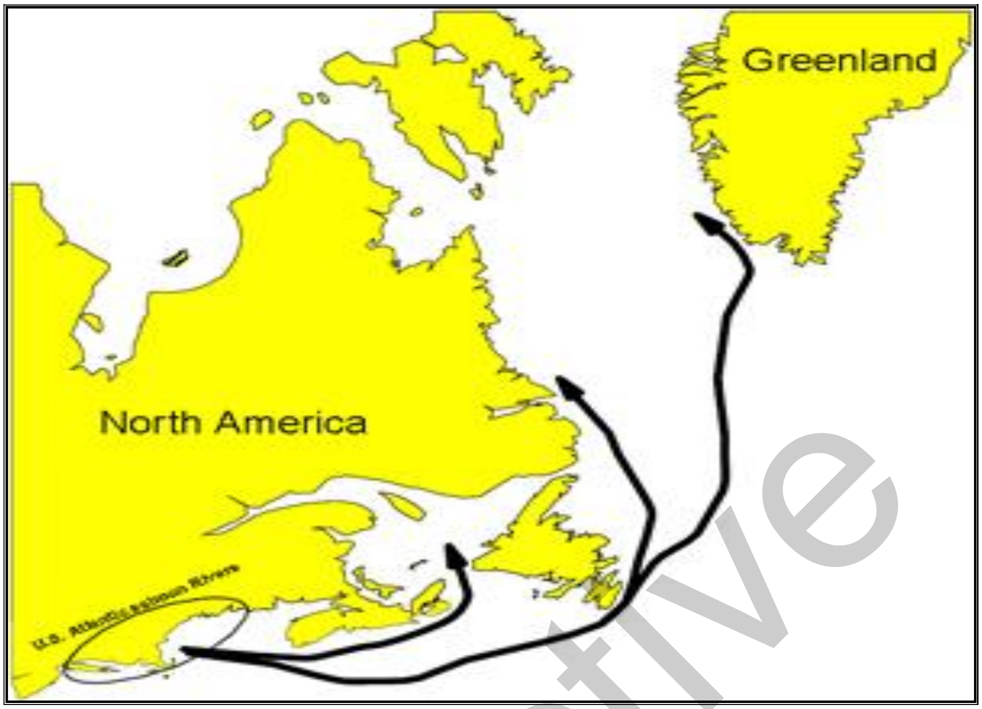
The current GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. The following impassable falls delimit the 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 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 (74 FR 29344; June 19, 2009).

Atlantic salmon have a complex life history that includes territorial rearing in rivers to extensive feeding migrations on the high seas (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.

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 refuge (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months.

Figure 2. GOM DPS of Atlantic Salmon Migration Route.



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 fresh water 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).

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. Some male parr may not go through smoltification and will become sexually mature and participate in spawning with sea-run adult females. These males are referred to as "precocious parr." First year parr are often characterized as being small parr or 0+ parr (four to seven centimeters long), whereas second and third year parr are characterized as large parr (greater than seven cm long) (Haines 1992). Parr growth is a function of water temperature (Elliott 1991); parr density (Randall 1982); photoperiod (Lundqvist 1980); interaction with other fish, birds, and mammals (Bjornn and Reiser 1991); and food supply (Swansburg *et al.* 2002). Parr movement may be quite limited in the winter (Cunjak 1988; Heggenes 1990); however, movement in the winter does occur (Hiscock *et al.* 2002) and is often necessary, as ice formation reduces total habitat availability (Whalen *et al.* 1999). Parr have been documented using riverine, lake, and estuarine habitats; incorporating opportunistic and active feeding strategies; defending territories from competitors including other parr; and working together in small schools to actively pursue prey (Gibson 1993; Marschall *et al.* 1998; Pepper 1976; Pepper *et al.* 1984; Hutchings 1986; Erkinaro *et al.* 1998a; O'Connell and Ash 1993; Erkinaro *et al.* 1995; Dempson *et al.* 1996; Halvorsen and Svenning 2000; Klemetsen *et al.* 2003).

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

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

During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56^{o}N. and 58^{o}N. (Reddin 1985; Reddin and Short 1991; Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish or MSW) and also includes immature salmon from both North American and European stocks (Reddin 1988; Reddin *et al.* 1988). The first winter at sea regulates annual recruitment, and the distribution of winter habitat in the Labrador Sea and Denmark Strait may be critical for North American populations (Friedland *et al.* 1993). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985; Dutil and Coutu 1988; Ritter 1989; Reddin and Friedland 1993; and Friedland *et al.* 1999). Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Reddin and Friedland (1993) found immature adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

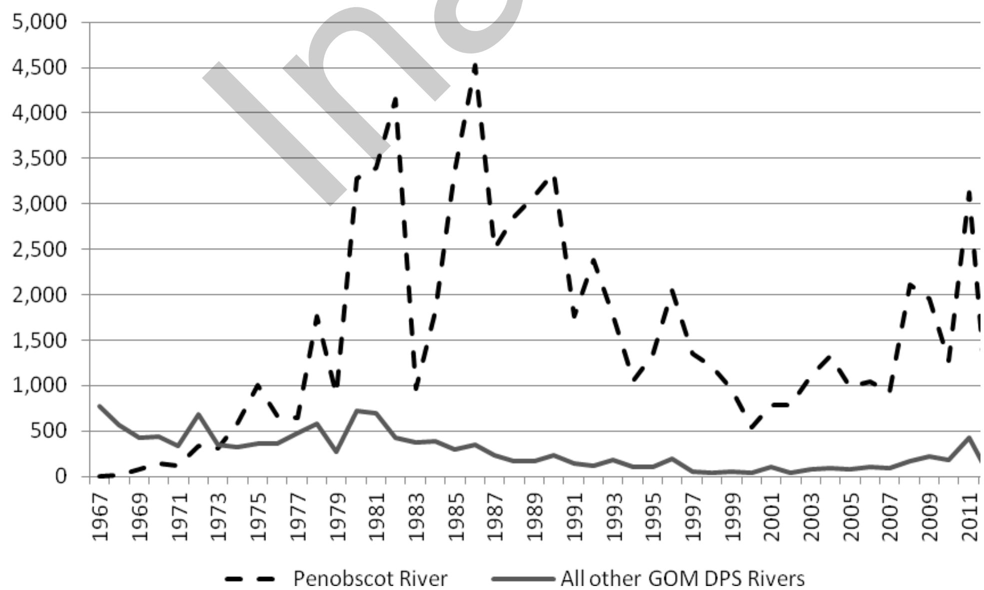
<u>3.1.2 Status and Trends of Atlantic Salmon in the GOM DPS</u>

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).

Contemporary abundance estimates are informative in considering the conservation status of the GOM DPS today. After a period of population growth in the 1970s, adult returns of salmon in the GOM DPS have been steadily declining since the early 1980s and appear to have stabilized at very low levels since 2000 (Figure 3). The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH that was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed throughout 1990s. The increase in the abundance of returning adult salmon observed between 2008 and 2011 may be an indication of improving marine survival.

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. 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 the result of smolt stocking and only the remaining 48 were naturally-reared. A total of 916 and 2,117 adult salmon returned to the Penobscot River in 2007 and 2008, respectively. Most of these returns were also of hatchery origin (USASAC 2008). The term naturally-reared includes fish originating from natural spawning and from hatchery fry (USASAC 2008). 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.

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



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

In conclusion, the 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) 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).

The status of Atlantic salmon critical habitat in the GOM DPS is important for two 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 PCEs essential for the conservation (*i.e.,* recovery) of the species. The complex life cycles exhibited by Atlantic salmon give rise to complex habitat needs, particularly during the freshwater phase (Fay *et al.* 2006). 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 waters 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 fresh water 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.

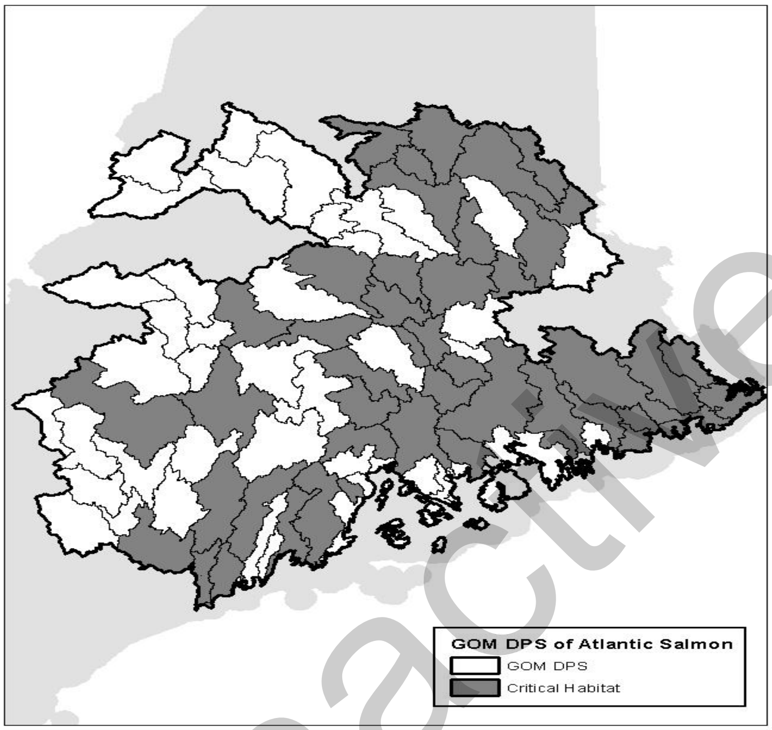
3.1.3.1 Primary Constituent Elements of Atlantic Salmon Critical Habitat

Designation of critical habitat is focused on the known primary constituent elements (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[1]). We chose not to separate

1 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.

spawning and rearing habitat into distinct PCEs, although each habitat does have distinct features, because of the GIS-based habitat prediction model approach that was used to designate critical habitat (74 FR 29300; June 19, 2009). This model cannot consistently distinguish between spawning and rearing habitat across the entire range of the GOM DPS.

Figure 4. HUC-10 Watersheds Designated as Atlantic salmon critical habitat within 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 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 three SHRUs include 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.

<u>Downeast Coastal SHRU</u>

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 of habitat in eleven HUC-10 watersheds are considered to be currently occupied. The Downeast 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 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.

<u>Penobscot SHRU</u>

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 of habitat 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.

<u>Merrymeeting Bay SHRU</u>

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 of habitat 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.

In conclusion, the June 19, 2009 final critical habitat designation for the GOM DPS (as revised on August 10, 2009) 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 lifestages of Atlantic salmon could be present in the action area of this consultation. From 2003 to 2007, an average of 30,000 fry was release annually to the Sandy River (Paul Christman, MDMR, 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, 600,000, 860,000 and 920,000 eggs respectively were release into the Sandy River. 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. 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 unforeseeable future.

In addition, some Atlantic salmon production is likely 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, Pers. comm. 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 (MDMR 2011a). Returning adult salmon at this first dam on the Kennebec River averaged eight fish per year from 1975 to 2000 and 18 per year fish from 2006 to 2010 (Table 2). In 2011, 64 adult Atlantic salmon returned to the Kennebec River (MDMR 2012). Monthly return data for 2009, 2010, and 2011 indicate peak adult returns occur in the months of June and July (Table 2). As of August 2012, only five Atlantic salmon have been captured at the Lockwood Dam fishway. In the Kennebec River, adult Atlantic salmon returns peak in June and July (Table 3).

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 (MDMR 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 (MDMR 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 (MDMR 2010). The total trap catch for 2011 was 64 adult sea-run Atlantic salmon; 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.

Table 2. Adult Atlantic salmon returns by origin to the Kennebec River recorded from 1975 to 2011.

	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Kennebec									
1975-2001	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**
Total for Kennebec	24	254	6	7	9	70	0	0	**370**

Source: USASAC 2011.

Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea, or over-winter 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.

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

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

Year	Maturity	Month of Capture						Total
		May	June	July	Aug	Sept	Oct	
	Domestic ♂	1	0	0	0	0	0	1
	Domestic ♀	3	0	0	0	0	0	3
	Domestic Unk[1]	0	1	0	0	0	0	1
	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
	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 Unknown	0	1	1	0	0	0	2
	Total	**0**	**33**	**29**	**0**	**1**	**1**	**64**

Source: MDMR 2010, 2011a, 2012.
Note: Unk[1] = Sex Unknown of Domestic Atlantic salmon

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 returning to the ocean. Little suitable spawning or rearing habitat occurs in the mainstem Kennebec River in the vicinity of EPA's proposed electrofishing sites. Thus, neither 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 spring of 2012, 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 in the lower reaches to sample outmigrating Atlantic salmon smolts. The Sandy River RST was operational from April 18, 2012 to May 30, 2012. A total of 52 smolts were captured during 29 days of sampling. The first smolt was captured on April 18 and the last smolt was captured on May 21. Peak capture of smolts occurred in the first week of May. Ambient water temperatures in the Sandy River during sampling ranged from 8° C to 19° C.

While the annual abundance of smolts in the Kennebec River is presently unknown, MDMR estimates the current egg stocking and natural reproduction in the Sandy River may be producing over 10,000 smolts annually. Smolt abundance is 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 4.1.2, critical habitat for Atlantic salmon has been designated in the Kennebec River watershed. One PCE for Atlantic salmon (sites for migration) is present in the action area as it was previously described section 4.1.2.1 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). 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 in regards 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. However, based on the proposed time of the study, only adult salmon are likely to be affected by the action.

Using this matrix along with information presented in FERC'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).

Approximately 208 miles of the Kennebec River and its tributaries, including all 10 reaches where sampling is proposed, are listed as impaired by the DEP. Combined sewer overflows (CSOs) from Skowhegan to the Gardiner-Randolph region on the river produce elevated bacteria levels, thus inhibiting recreation uses of the river (primary contact). Further, the Kennebec River has restricted fish consumption 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, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons).

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^oC and 7.2^oC, averages nearly 6oC from fertilization to eye pigmentation	averages < 4oC, or 8 to 10^oC from fertilization to eye pigmentation	>10^oC 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

Table 4 continued...

PCE	Essential Features	Conservation Status Baseline Fully Functioning	Limited Function	Not Properly Functioning
C) Parr Development: (All year)				
	Substrate	gravel between 1.6 and 6.4 cm in diameter and boulders between 30 and 51.2 cm in diameter. May contain rooted aquatic macrophytes	gravel < 1.2cm and/or boulders > 51.2. May contain rooted aquatic macrophytes	no gravel, boulders, or rooted aquatic macrophytes present
	Depth	10cm to 30cm	NA	<10cm or >30cm
	Velocity	7 to 20 cm/sec.	< 7cm/sec. or > 20 cm/sec.	velocity exceeds 120 cm/sec..
	Temperature	15^o to 19^oC	generally between 7-22.5oC, but does not exceed 29oC at any time	stream temperatures are continuously <7oC or known to exceed 29oC
	D.O.	> 6 mg/l	2.9 - 6 mg/l	< 2.9 mg/l
	Food	Abundance of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Presence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Absence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows
	Passage	No anthropogenic causes that inhibit or delay movement	Presence of anthropogenic causes that result in limited inhibition of movement	barriers to migration known to cause direct inhibition of movement
	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

Table 4 continued…

PCE	Essential Features	Conservation Status Baseline: 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 20oC 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 - 11oC	5 - 11^{o}C.	< 5oC or > 11oC
	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

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

Pathway/Indicator	Life Stages Affected	PCEs Affected	Effect	Population Viability Attributes Affected
Passage/Access to Historical Habitat	Adults/ smolts	Freshwater migration	Impaired water quality.	Adult abundance and productivity.

3.1.5 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 action area, the controlled release of impounded 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, which have been replaced by lacustrine communities following construction of a 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 project (Mesa 1994; Ward *et al.* 1995; Ferguson *et al.* 2006).

- ***Predation***

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).

Smallmouth bass are important predators of smolts in main stem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993).

Chain pickerel are known to feed upon smolts within the range of the GOM DPS and certainly feed upon fry and parr, as well as smolts, given their piscivorous feeding habits (Van den Ende 1993).

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

Many species of birds also prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell *et al.* (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at main stem dam foraging sites. Common mergansers and belted kingfishers are likely the most important predators of Atlantic salmon in freshwater environments.

- ***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 Title 12, section 403; navigation; and as a habitat for fish and other aquatic life. In their 2010 Integrated Water Quality Monitoring and Assessment Report, Maine DEP describes the Kennebec and Sebasticook River action areas as impaired due to elevated levels of two environmentally persistent carcinogenic compounds (*i.e.*, dioxin and polychlorinated biphenyls).

The Maine Department of Environmental Protection (DEP) issues permits under the National Pollutant Discharge Elimination System (NPDES) for licensed point source discharges. Conditions and license limits are set to maintain the existing water quality classification. 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, the DEP calculates a total maximum daily loads (TMDL) 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 has added 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.

3.1.5.1 Summary of Factors Affecting Recovery of Atlantic Salmon

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

3.1.5.2 *Threats to the Species*

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 are writing a new recovery plan that 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

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

- Degraded water quality
- Aquaculture practices, which pose ecological and genetic risks
- Climate change
- Depleted diadromous fish communities
- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon
- Poaching of adults in DPS rivers
- 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 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 (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.

3.1.5.3 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 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 or still do occur, at least to some extent, in each of the three SHRUs.

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 Merrymeeting Bay SHRU significantly impede the migration of Atlantic salmon and other diadromous fish and either reduce or eliminate access to roughly 352,000 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 reducing substrate and cover, reducing water quality, and elevating water temperatures. Additionally, smallmouth bass and brown trout introductions, along with other non-indigenous species, significantly degrade habitat quality throughout the Merrymeeting Bay SHRU by altering natural predator/prey relationships.

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 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 predominate 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.

3.1.5.4 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. These efforts are supported by a number of federal, state, and local government agencies, as well as many private conservation organizations. The 2005 recovery plan for the originally-listed GOM DPS (NMFS and USFWS 2005) presented a strategy for recovering Atlantic salmon that focused on reducing the most severe threats to the species and immediately halting the decline of the species to prevent extinction. The 2005 recovery program included the following elements:

1. Protect and restore freshwater and estuarine habitats;
2. Minimize potential for take in freshwater, estuarine, and marine fisheries;
3. Reduce predation and competition for all life-stages of Atlantic salmon;
4. Reduce risks from commercial aquaculture operations;
5. Supplement wild populations with hatchery-reared DPS salmon;
6. Conserve the genetic integrity of the DPS;
7. Assess stock status of key life stages;
8. Promote salmon recovery through increased public and government awareness; and
9. Assess effectiveness of recovery actions and revise as appropriate.

A wide variety of activities have focused on protecting Atlantic salmon and restoring 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. In light of the 2009 GOM DPS listing and designation of critical habitat, the Services will produce a new recovery plan for the expanded GOM DPS of Atlantic salmon.

3.1.6 Summary of Information on Atlantic Salmon in the Action Area

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

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

3.2 Shortnose Sturgeon

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

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 and 42 (Parker 2007).

The juvenile phase can be subdivided in to young of the year (YOY) and immature/ sub-adults. YOY and sub-adult habitat use differs and is believed to be a function of differences in salinity tolerances. Little is known about YOY behavior and habitat use, though it is believed that they are typically found in channel areas within freshwater habitats upstream of the 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). Sub-adults 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 sub-adults may overwinter in different areas than adults and do not form dense aggregations like adults (ERC Inc. 2007). Sub-adults feed indiscriminately; typical prey items found in stomach contents include aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Dadswell 1979; Carlson and Simpson 1987; Bain 1997).

In populations that have free access to the total length of a river (e.g., no dams within the species range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures reach between 7 - 9.7ºC (44.6 - 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 the 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 - 15ºC (46.4 - 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 - 18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.* 1984). Between 8°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.

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

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell *et al.* 1984; Hall *et al.* 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell *et al.* 1984; Buckley and Kynard 1985; O'Herron *et al.* 1993). Kieffer and Kynard (1993) reported that postspawning 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. 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 basin movements have been documented between the GOM rivers and the Merrimack, between the Connecticut and Hudson rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

Recent tagging data (Little *et al.* 2013) indicates that small numbers of shortnose sturgeon do make coastal migrations to adjacent rivers and beyond. During the period 2009 through 2013 researchers from U.S. Geologic Survey, University of New England, University of New Hampshire, and Maine Department of Marine Resources tagged and tracked four individual shortnose sturgeon that migrated north from the Merrimack River. Most of these fish were subsequently identified in the Piscataqua and Saco Rivers before they were detected entering the Kennebec River where they remained 2-3 weeks prior to returning to the Merrimack via the Saco and Piscataqua. (Micah Kieffer, personal conversation, 2013). These 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. 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 over-wintering and spawning runs, coupled with telemetry data, shortnose sturgeon are most likely to occur in the action area mid to late spring when the water temperature is warmer than 8^{o}C.

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 to 3ºC (35.6-37.4°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 28-30ºC (82.4-86°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 the 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.

<u>3.2.1 Status and Trends of Shortnose Sturgeon Rangewide</u>

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 century's, 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 recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (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 compromised of breeding subpopulations (NMFS 1998).

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

Grunwald *et al.* (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern 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 re-colonized. 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. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes vary across the species range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, United States Geological Survey, personal communication; 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 1000 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) expected abundance of adults in northern and north-central populations should be 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 range wide, 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.

3.2.2 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.

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 resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to 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 organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (*i.e.*, PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" 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 semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

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

Pulp mills, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (82.4°F) (Flourney *et al.* 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

3.2.3 Status of Shortnose Sturgeon in the Action Area

Since the removal of the Edwards Dam in 1999, numerous studies have been conducted by state and federal agencies on habitat re-colonization. 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 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.

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 2011 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.

During the period 2010 through 2013 researchers from USGS, UNE, University of New Hampshire, and Maine Department of Marine Resources (MEDMR) also tagged and tracked four individual shortnose sturgeon that migrated north from the Merrimack River. These fish were subsequently detected in the Piscataqua and Saco Rivers before entering the Kennebec River where they remained 2-3 weeks before they returned to the Merrimack via the Saco. (Micah Kieffer, personal conversation, 2013). These four fish made multiple coastal migrations during the study period. 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).

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 8-9°C. Shortnose sturgeon typically spawn at the most upstream accessible site with suitable conditions. Spawning sites have been identified in the Kennebec River near Gardiner. 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.

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 period 2011-2012 shortnose sturgeon overwintered in the deep water channels between Hallowell and Farmingdale, Maine, approximately one kilometer upstream of Brown's Island (G. Wipplehauser, MDMR, personal communication 2012).

As more suitable habitat becomes available as result of dam removals and restoration projects, 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

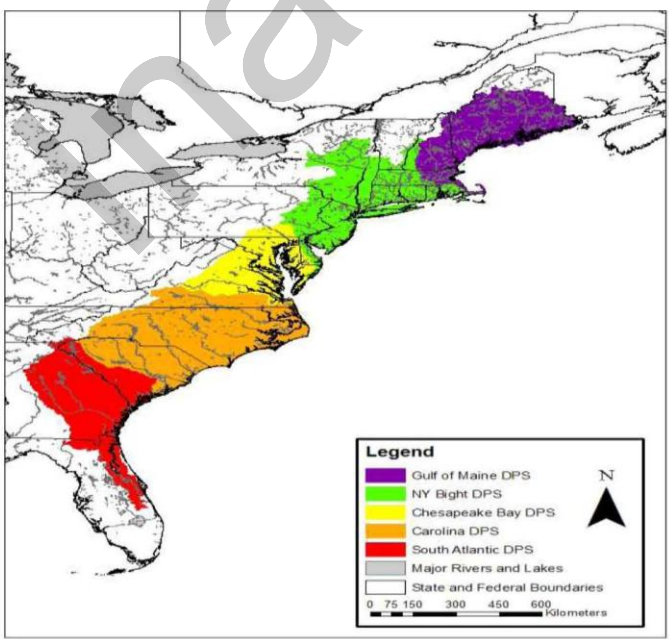
The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon and then provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of which Atlantic sturgeon DPSs likely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

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, USA (Scott and Scott 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). We have has delineated U.S. populations of Atlantic sturgeon into five DPSs[2] (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (Figure 5). 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 occurs 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.

On February 6, 2012, we published notice in the *Federal Register* that we were listing the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs as "endangered," and the Gulf of Maine DPS as "threatened" (77 FR 5880 and 77 FR 5914). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listing.

Figure 5. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs



2 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. 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 (93% Gulf of Maine DPS (60% St. John, 40% Kennebec) and 7% New York Bight DPS). 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 93% (60-100% Kennebec and ~0-40% St. John (Canada)) and 7% New York Bight. 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 are provided below.

3.3.2 Atlantic Sturgeon Life History

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[3] fish (Bigelow and Schroeder 1953; Vladykov and Greeley 1963; Mangin 1964; Pikitch *et a.* 2005; Dadswell 2006; ASSRT 2007). The life history of Atlantic sturgeon can be divided up into five general categories as described in Table 6 below (adapted from ASSRT 2007).

Table 6. Descriptions of Atlantic sturgeon life history stages.

Age Class	**Size**	**Description**
Egg		Fertilized or unfertilized
Larvae		Negative phototaxic, nourished by yolk sac
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
Sub-adults	>41 cm and <150 cm TL	Fish that are at least age 1 and are not sexually mature
Adults	>150 cm TL	Sexually mature fish

They are a relatively large fish, even amongst sturgeon species (Pikitch *et al.* 2005). Atlantic

3 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).

sturgeon are bottom feeders that suction food into a ventrally-located protruding mouth (Bigelow and Schroeder, 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder 1953; ASSRT 2007; Guilbard *et al.* 2007; Savoy 2007). While in the river, 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; (3) fully mature females attain a larger size (*i.e.* length & girth) than fully mature males; and (4) the length of Atlantic sturgeon caught since the mid-late 20th century have typically been less than 3 meters (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).

The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 meters (Vladykov and Greeley 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.* 1982; Van Eenennaam *et al.* 1996; Van Eenennaam and Doroshov 1998; Dadswell 2006). However, 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 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). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (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 Atlantic sturgeon occur in low salinity waters of their 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 their 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). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 m during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 m in summer and fall (Erickson *et al.* 2011). Shirey (Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009) found a similar movement pattern for juvenile Atlantic sturgeon based on recaptures of fish originally tagged in the Delaware River. After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras, North Carolina from November through early March. In the spring, a portion of the tagged fish reentered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall. The majority of these tag returns were reported from relatively shallow near shore fisheries with few fish reported from waters in excess of 25 meters (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia/North Carolina border to Cape Hatteras at depths up to 24 m (Dovel and Berggren 1983; Dadswell *et al.* 1984; Johnson *et al.* 1997; Rochard *et al.* 1997; Kynard *et al.* 2000; Eyler *et al.* 2004; Stein *et al.* 2004; Wehrell 2005; Dadswell 2006; ASSRT 2007; Laney *et al.* 2007). These sites may be used as foraging sites and/or thermal refuge.

3.3.3 Distribution and Abundance

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and Crossman 1973; Taub 1990; Kennebec River Resource Management Plan 1993; Smith and Clugston 1997; Dadswell 2006; ASSRT 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware, and at least 10,000 females for other spawning stocks (Secor and Waldman 1999; Secor 2002). Historical records suggest that Atlantic sturgeon spawned in at least 35 rivers prior to this period. Currently, only 16 U.S. rivers are known to support spawning based on available evidence (*i.e.* presence of young-of-year or gravid Atlantic sturgeon documented within the past 15 years) (ASSRT 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only four rivers (Kennebec, Hudson, Delaware, James) are known to currently support spawning from Maine through Virginia where historical records support there used to be fifteen spawning rivers (ASSRT 2007). While spawning may also be occurring in other rivers, such as the Piscataqua or Penobscot Rivers, we do not yet have confirmation there or in other likely northeast rivers. Thus, there are substantial gaps in the range between Atlantic sturgeon spawning rivers amongst northern and Mid-Atlantic States which could make recolonization of extirpated populations more difficult.

There are no current, published population abundance estimates for any of the currently known spawning stocks. Therefore, there are no published abundance estimates for any of the five DPSs 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). 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 River and Altamaha River 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.

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). Similar to other sturgeon species (Vladykov and Greeley 1963; Pikitch *et al.* 2005), Atlantic sturgeon experienced range-wide declines from historical abundance levels due to overfishing (for caviar and meat) and impacts to habitat in the 19th and 20th centuries (Taub 1990; Smith and Clugston 1997; Secor and Waldman 1999).

Based on the best available information, we have 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. 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 Atlantic States Marine Fisheries Commission (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 us 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 are likely to originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Fisheries bycatch in U.S. waters is the primary threat faced by all 5 DPSs. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Federal FMPs (NMFS NEFSC 2011) in the Northeast Region but do not have a similar estimate for Southeast fisheries; nor do we 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.

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 by catch 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 are also not able to quantify any effects to habitat.

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin and Saco Rivers, these dams are near the site of 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 project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie Dam which currently prevents Atlantic sturgeon from accessing approximately 29 km of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. While removal of the Veazie Dams is currently underway, its continued presence still prevents access to potential spawning habitat within the Penobscot River. 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 Veazie Dam affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Veazie Dam on the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring 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. The Atlantic sturgeon 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

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

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy (Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

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

<u>3.3.6 New York Bight DPS of Atlantic Sturgeon</u>

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.

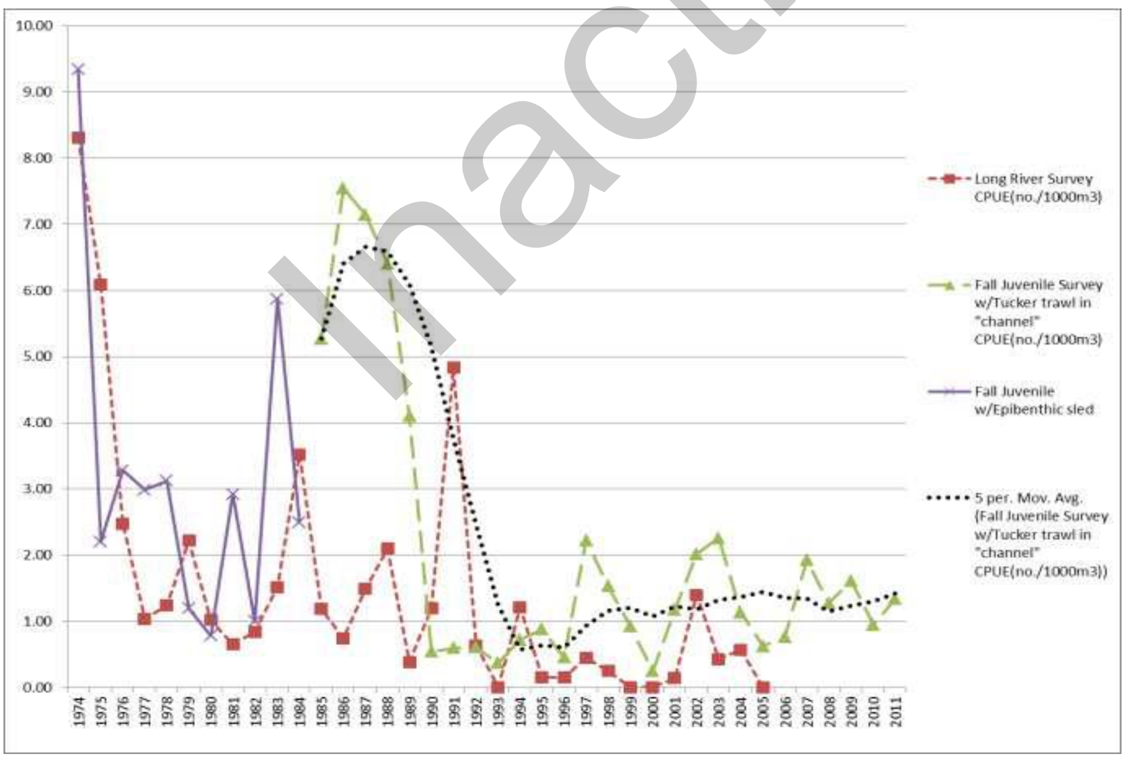
In October of 1994, the New York State Department of Environmental Conservation (NYDEC) stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews 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 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) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data which are collected from May - July provide an annual index of juvenile Atlantic sturgeon in the Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July – October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early 1990s. While the amount of 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 when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003–2005, 579 juveniles were collected (N=122, 208, and 289, respectively) (Sweka *et al.* 2006). Pectoral spine analysis showed they ranged from 1–8 years of age, with the majority being ages 2–6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles. 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, longterm indices of juvenile abundance (the Hudson River Long River and Fall Shoals surveys) demonstrate a longterm declining trend in juvenile abundance. Figure 5, below, illustrates the CPUE of Atlantic sturgeon in the two longterm 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 5. CPUE of Atlantic sturgeon in the two longterm 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 this 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

Atlantic sturgeon originating from the New York Bight DPS spawn in the Hudson and Delaware rivers. While genetic testing can differentiate between individuals originating from the Hudson or Delaware river the available information suggests that the straying rate is high between these rivers. There are no indications of increasing abundance for the New York Bight DPS (ASSRT 2009; 2010). Some of the impact from the threats that contributed to the decline of the New York Bight DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes remain significant threats to the New York Bight DPS.

In the marine range, New York Bight 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, currently available estimates indicate that at least 4% of adults may be killed as a result of bycatch in fisheries authorized under Northeast FMPs. Based on mixed stock analysis results presented by Wirgin and King (2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the New York Bight DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the New York Bight DPS. 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.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey. 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.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the New York Bight region is currently unknown.

New York Bight DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006; EPA 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

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

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman 1997; ASMFC 2007; Kahnle *et al.* 2007; Brown and Murphy 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the New York Bight DPS. As described in the final listing rule, we have determined that the New York Bight DPS is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect population recovery.

4. ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). 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. 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 solely the action area.

4.1 Formal or Early Section 7 Consultations

We completed ESA section 7 consultation for the Lockwood Hydroelectric Project (2005) and dredging at Bath Iron Works (2012). No take of Atlantic salmon were exempted in any of these consultations.

We also completed two formal consultations (2011) for Central Maine Power activities in Bond Brook, a tributary to the Kennebec River in Augusta, Maine. The first project involved coal tar remediation in the brook. The second project involved upgrades to a combined sewer overflow in Bond Brook. We exempted the non-lethal take of two adult Atlantic salmon for each project.

Lastly, we have completed four formal consultations concerning your support of long term bioassessment studies in the Kennebec River (2009, 2010, 2011, and 2012). We exempted the non-lethal take of adult Atlantic salmon for each year of the study. No salmon were encountered in either 2009 or 2010. In 2011, four Atlantic salmon were encountered. Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon were all encountered during the 2012 sampling season.

4.2 Scientific Studies

MDMR 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 MDMR 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%. MDMR will continue to conduct Atlantic salmon research and management activities in the Kennebec River watershed while the 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 the conservation hatchery program at the Craig Brook and Green Lake National Fish Hatcheries. The mission of the hatcheries is to raise Atlantic salmon parr and smolts for stocking into selected Atlantic salmon rivers in Maine. Over 90% of adult returns to the 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 (May 2012), and will extend until 2017. The research team consists of scientists from MDMR, 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, anesthetize, 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. 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

4.3 Other Federally Authorized Activities in the Action Area

Through a letter of memorandum signed on January 12, 2001, the EPA has conferred authority to the State of Maine Department of Environmental Protection to manage its own (water) pollution discharge and elimination program. 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 have been reported in association with either of those projects.

4.3.1 Publically Owned Waste Treatment Facility

The Kennebec Sanitary Treatment District owns and operates a wastewater treatment facility that discharges secondary treated effluent outfall 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 facility has exceeded its authorized concentration or volume of a variety of pollutants six different times in a three year period (2010-2013). 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.

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. .

4.4 State or Private Activities in the Action Area

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.

The Maine Department of Marine Resources (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.

4.5 Impacts of Other Human Activities in the Action Area

Other human activities that may affect listed species and critical habitat include direct and indirect modification of habitat due to hydroelectric facilities and the introduction of pollutants from paper mills, sewers, and other industrial sources. Hydroelectric facilities can alter 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 downstreamy. 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

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) and 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. 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 0.2oC (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 high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

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). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. 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.

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 is likely to affect in-stream flow, the physiological, behavioral, and feeding-related mechanisms of Atlantic salmon are also likely to be impacted (Friedland 1998). With changes in in-stream flow, salmon found in smaller river systems may experience upstream migrations that are confined to a narrower time frame, as small river systems tend to have lower discharges and more variable flow (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.

5.3 Effects on Shortnose Sturgeon

Global climate change may affect shortnose sturgeon in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers. Shortnose sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile shortnose sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, shortnose 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 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 shortnose 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 Effects on Atlantic Sturgeon

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to affect the South Atlantic and Carolina DPSs. Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile Atlantic sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, Atlantic sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the salt wedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the salt wedge. It is unlikely that shifts in the location of the salt wedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

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

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all Atlantic sturgeon life stages, including adults, may become susceptible to strandings or habitat restriction. Low flow and drought conditions are alsoexpected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat.

5.5 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.

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 (Mass.), and Boothbay Harbor (Maine) and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing; for example, Boothbay Harbor's temperature has increased by about 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 - 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 2019) 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 four 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 (see Damon-Randall *et al.* 2010); in the wild, shortnose sturgeon are typically found in waters less than 28°C. 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 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°C 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.

The effects of climate change will not increase appreciably during the proposed survey period. However, less snow may fall each winter only to be replaced by rain. Additionally, increased rainfall will result in more run-off which in turn will likely reduce water quality in the action area.

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 of the action area. Another potential impact of climate change is the disruption of the synchronization of naturally occurring biological events. If adult salmon encounter riverine temperatures greater than 23^{o} C, they are likely to abandon their upstream spawning migration resulting in depressed reproductive success rates. If the outmigrating 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.

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 still 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). 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 take place in the fall (September/October). 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

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 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 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 sub-adults.

As evidenced by the counts of Atlantic salmon at the Lockwood fish lift from 2009 to 2011 (Table 3), the number of returning adults in the Kennebec River is greatest during the spring and early summer. During late summer and fall (August to October), only two fish have used the Lockwood fishway from 2009 to 2011. Based on this information, we expect few Atlantic salmon to be present in the action area during September and October. 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 supported by data collected during prior bioassessment 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 DMR at the Lockwood Dam. A solitary Atlantic salmon was encountered on Sep. 25, 2012 approximately 100 meters downstream from the Lockwood Dam spillway near Winslow, ME; it too swam away apparently unharmed.

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.

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 2006-2011;
- the number of Atlantic salmon captured at the Lockwood fish lift in September 2006-2011;
- 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 four-year study.

Similar factors were considered when estimating the number of Atlantic and/or Shortnose sturgeon that may be encountered during electrofishing. However, we do not have a decade of sturgeon return or encounter data on which to base our estimates. With no definitive population estimate for either sturgeon species habituating the Kennebec River, we must base our estimates on encounters from other research as well as overwintering aggregation estimates of shortnose sturgeon from DMR. Considering sturgeon seasonal inter and intra-river movement and deep water habitat preference, we expect that no more than one adult or sub-adult Atlantic or Shortnose sturgeon will encounter the electric current associated with the electrofishing gear annually during the four-year study.

The electrofishing survey to be undertaken in the Kennebec River watershed will be performed pursuant to protocols developed specifically by the MASC to minimize the potential for injury or mortality to listed species. Mortality rates during electrofishing surveys carried out by MDMR in the GOM DPS of Atlantic salmon have annually remained below 1% (MDMR unpublished data). Documented mortality of large parr during MASC electrofishing surveys in the Narraguagus has been less than 0.1%. No injury or mortality of Atlantic salmon, Atlantic or Shortnose sturgeon of any life stage is expected as 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, one shortnose sturgeon, and one Atlantic sturgeon that may encounter electrical current used in electrofishing annually during the survey; none are expected to experience mortality. Exposed fish may be temporarily stunned and may roll or twitch. It is also likely that any adult Atlantic salmon, Atlantic and/or Shortnose sturgeon encountered during electrofishing will 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.

In summary, based on the limited size of the effective area of the electrofishing boat and the likely distribution of Atlantic salmon, Atlantic and Shortnose sturgeon in the action area, no more than four Atlantic salmon, one Shortnose sturgeon, and one Atlantic sturgon are expected to be affected annually during the four 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 for other electrofishing surveys in the Kennebec River. As explained above, this survey has taken place for the last eight years and only 10 anadromous Atlantic salmon and two sturgeon have been observed.

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 (PCE) for designated critical habitat of listed Atlantic salmon in the action area are:

1) Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations;
2) Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation; and,
3) Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

We have analyzed the potential impacts of the project on designated critical and PCEs in the action area. We have determined that the effects to these PCEs will be insignificant for the reasons outlined below.

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, and 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. This will ensure that there is always a sufficient zone of passage past the electrofishing operation for any adult Atlantic salmon moving upstream past the area being sampled. The project will not alter the habitat in any way that would increase the risk of predation. Any effects to the water column will be limited to temporary electrification; there will be no other water quality impacts of the proposed action and therefore the project is not expected to affect water quality at the time of any salmon migrations in the action area. The types of species that will be stunned by the electrofishing gear and be subject to capture by the researchers are not likely to be the same species that juvenile or adult Atlantic salmon forage on; 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, and natural cover to meet the conservation needs of listed Atlantic salmon. Based upon this reasoning, we have determined that any 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 effects of future state and private activities in the action area that are reasonably certain to occur during the proposed action are recreational and commercial fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

The best available information indicates that Atlantic salmon are still incidentally caught by recreational anglers. Evidence suggests that Atlantic salmon are also targeted by poachers (NMFS 2005). Commercial fisheries for elvers, Guvenile eels, and alewives may also capture Atlantic salmon shortnose and Atlantic sturgeon as bycatch. No estimate of the numbers of listed species caught incidentally in recreational or commercial fisheries 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.

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. <u>INTEGRATION AND SYNTHESIS OF EFFECTS</u>

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, and 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, and 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 Section 7 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 in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter."

Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(l) of the Act." Below, for the three listed species found in the action area, 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 considers 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 that species, as those terms are defined for purposes of the federal ESA.

We have determined that the proposed action will result in harassment of Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon in the action area. Lethal injuries and/or mortalities can be eliminated by adhering to electrofishing protocol; therefore we do not anticipate any injury or mortality of Atlantic salmon, shortnose sturgeon, or Atlantic sturgeon as a result of the fish assemblage survey activities.

8.1 GOM DPS of Atlantic Salmon

The GOM DPS of Atlantic salmon is listed as endangered throughout its range. Atlantic salmon in the GOM DPS currently exhibit critically low spawner abundance, poor marine survival, and are still confronted with a variety of threats. Numbers of endangered adult Atlantic salmon returning to the GOM DPS are extremely low, with only 1014 adults in 2007, and only 16 of these returning to the Kennebec (NMFS and USFWS 2009). Based upon the best available scientific information, we have determined that the proposed study will result in the exposure of four adult Atlantic salmon annually to the electric current associated with the electrofishing equipment for the next four years. Based upon assumptions outlined in this Opinion, no incidental mortality of Atlantic salmon is likely to occur during the project. No Atlantic salmon of any life stage are expected to be injured or killed as a result of the proposed action.

8.1.1 Summary of Sampling Effects

This action will not reduce reproduction of Atlantic salmon in the Kennebec River watershed because it will (1) not result in the mortality of any Atlantic salmon and therefore will not affect any potential reproduction of that individual; (2) not affect any spawning adults; (3) not affect spawning habitat; and (4) as recovery from exposure is expected to be rapid and complete, will not affect the reproductive fitness of any individual by reducing fecundity or increasing the interval between spawning.

This action will not reduce the numbers of Atlantic salmon in the Kennebec River watershed because it will not result in the mortality of any Atlantic salmon. The proposed action will not reduce distribution because the action will not impede Atlantic salmon from accessing any habitat, including spawning, foraging or overwintering grounds in the Kennebec River watershed. Further, the action is not expected to reduce the river by river distribution of Atlantic salmon.

For these reasons, we believe that there is not likely to be any reduction in reproduction, numbers or distribution of GOM DPS Atlantic salmon. As there will not be a reduction in reproduction or numbers of Atlantic salmon and no reduction in the rangewide distribution of this species, this action is not likely to impede the ability of the species to recover. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery in the wild of the Kennebec River SHRU or the species as a whole.

8.1.2 Survival Analysis

Jeopardy is defined 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" (50 CFR 402.02). Therefore, to determine if the proposed action will jeopardize the GOM DPS of Atlantic salmon, we conduct an analysis of the effects of the proposed action on survival and recovery.

The first step in conducting this analysis is to assess the effects of the proposed action on the survival of the species. Survival is defined as 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 (USFWS and NMFS 1998).

There are three criteria that are evaluated under the survival analysis: reproduction, numbers and distribution. We consider the number of returning adult Atlantic salmon, particularly 2SW females, to the natal streams is a measure of both the reproduction and numbers of the species. We consider the proportion of runs where pre-spawn Atlantic salmon are able to access high quality spawning and rearing habitat in the upper Kennebec River watershed as a reasonable and appropriate measure of distribution. As the vast majority of high quality spawning and rearing habitat in the Kennebec River basin exists in the Sandy River, we consider improved access to/from these areas to be critical to the survival and recovery of the species. The survival analysis assumes that the accessibility is maintained over the time period considered in this consultation.

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 the 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, numbers and distribution. In the recovery analysis, the same measures are used to evaluate these criteria as are used in the survival analysis. However, unlike with survival, the recovery analysis requires an adjustment to the existing freshwater and marine survival rates to allow for a population that has a positive growth rate, so that it can be determined how the proposed project will affect the species ability to achieve recovery. Such an analysis could not be conducted under existing freshwater and marine survival conditions, since they do not allow a population trending towards recovery. The recovery condition includes existing dam passage rates, 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.

The proposed sampling activities will not result in the mortality of any Atlantic salmon. The proposed action will therefore, not affect the abundance of this species. There will also be no effects to reproduction. Potential affects to distribution will be limited to the temporary response to electrical current by an extremely small number of individuals at 11 discrete locations. As explained fully below, we have determined that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the species.

8.1.2.1 Abundance and Reproduction

For the period of 1967 to 2003, approximately 10% of the wild and naturally reared origin adults returning to U.S. rivers (with monitoring facilities) were grilse and 86% were 2SW (USASAC 2004). An occasional 3SW salmon is found among returning adults. In Maine, 95 to 98% of the grilse are male while 55 to 75% of the 2SW and 3SW returns are female (Baum 1997). From when fish trapping and monitoring began at the Lockwood Dam in 2006, there have been an average of 22.7 adult salmon return annually (MDMR, 2012). Based on the statics provided above, we conclude that between 12 and 17 of those returning 2SW fish were female. Based on historical records and the current trajectory it can be said that, although the Atlantic salmon population is still declining, the proposed biological assessment will have no influence on the abundance of returning 2SW female Atlantic salmon to the Kennebec River and the GOM DPS of Atlantic salmon.

8.1.2.2 Distribution

We conducted a separate analysis to assess the effects of the bridge replacement on the distribution of Atlantic salmon in the Kennebec River watershed. In this analysis, the proportion of salmon that access habitat upstream of the action area is compared to the baseline condition and the condition after the bridge replacement. The analysis indicates that the proposed project is not anticipated to lead to any improvements or reduction in the distribution of Atlantic salmon in the Kennebec River, and GOM DPS as a whole. T herefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic salmon will survive.

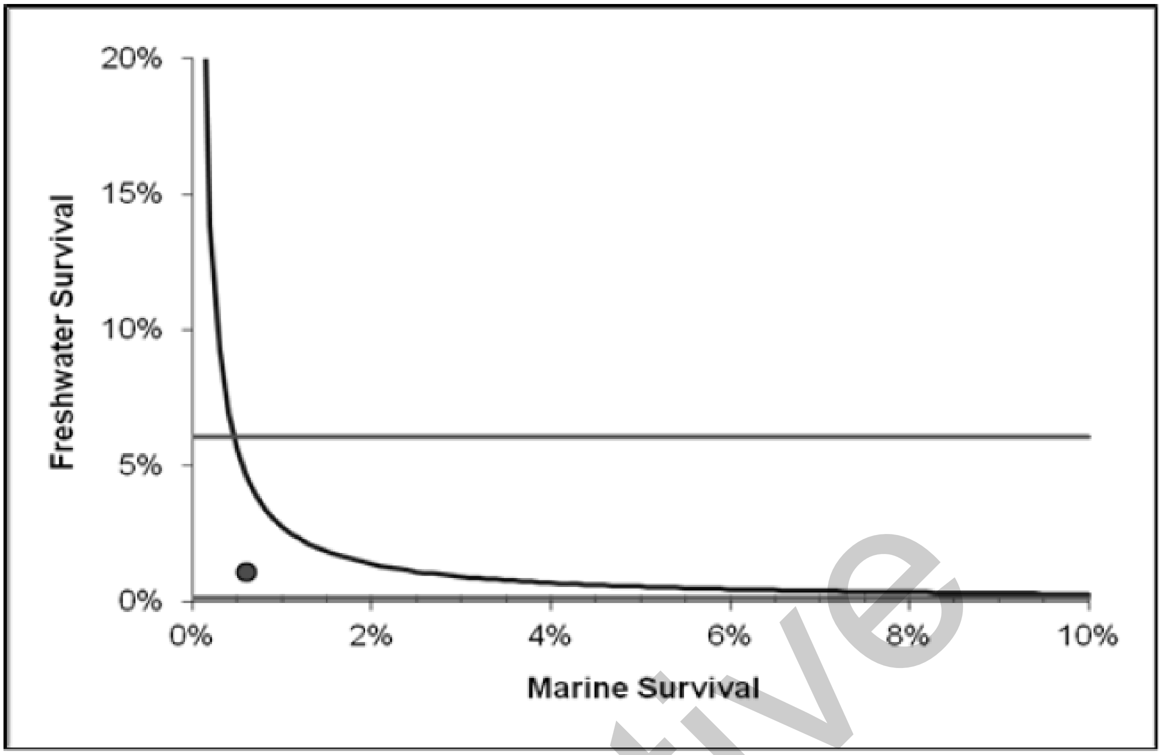
<u>8.1.3 Recovery Analysis</u>

In rare instances an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that Atlantic salmon 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.

At existing freshwater and marine survival rates (the medians have been estimated by us as 1.1% and 0.4%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. As indicated in the survival analysis above, at current survival rates wild spawners are having a very small effect on the number of returning salmon. If hatchery supplementation were to cease, the population would decline rapidly, and recovery would not be possible. Therefore, a significant increase in either freshwater or marine survival (or a lesser increase in both) will be necessary to achieve recovery. The Atlantic Salmon Recovery Team (ASRT) created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (ASRT 2010). In Figure 6, 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). The straight lines indicate the 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 to occur, path to achieving a self-sustaining population that is trending towards recovery.

Figure 6. NMFS (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).



In order to model the effect that the proposed action would have on recovery, marine and freshwater survival rates are increased to a point that will allow for the recovery of the species. To do this, assumptions are made about what constitutes a realistic increase in these parameters. 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 for 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%) creates 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.

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.

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 life of the proposed action *(i.e.*, through the construction period). 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.

8.1.4 Critical Habitat for Atlantic salmon

As explained above, the proposed action will have only an insignificant effect on critical habitat designed for the GOM DPS of Atlantic salmon. This conclusion is based on the determination that there will be no permanent impacts to the habitat and because: (1) the project will not result in a migration barrier to or through any estuarine habitat; (2) the project will not increase the risk of predation; (3) the project is not expected to affect water quality at the time of any salmon migrations in the action area; (4) the project will not significantly affect the forage of juvenile or adult Atlantic salmon because of the timing and location; and, (5) there will be no effects to the natural structure of the nearshore habitat and therefore there will be no reduction in the capacity of substrate, food resources, and natural cover to meet the conservation needs of listed Atlantic salmon.

8.2 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 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 population 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, add 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.

Shortnose sturgeon occur in the estuarine complex formed by the Sheepscot, Kennebec, and Androscoggin rivers. Fried and McCleave (1973) discovered shortnose sturgeon within Montsweag Bay in the Sheepscot River in 1971. This was the first documented occurrence of shortnose sturgeon in Maine. Shortnose were subsequently found in the Kennebec River by ME DMR in 1977 (Squiers and Smith, 1979). Sturgeon were tagged with Carlin tags from 1977 to 1980, with recoveries in each of the following years. The Maine Department of Marine Resources (MDMR) conducted studies of shortnose sturgeon in the Kennebec River from 1996 through 2001. A Schnabel estimate using tagging and recapture data from 1998, 1999 and 2000 indicates an adult population estimate of 9,488 for the Kennebec- Androscoggin- Sheepscot estuarine complex (Squires 2003). This 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, but does not include an estimate of the size of the juvenile population.

In 1999, the Edward's Dam, which represented the first significant impediment to the northward migration of shortnose sturgeon 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, MDMR 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). It is likely that the major spawning area for shortnose sturgeon in the Kennebec River is located in the first 11 km below the former Edwards Dam site (rkms 59-70)(Tom Squiers, MDMR, Personal Communication). 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^{o}C. While there have not been any directed studies to determine if shortnose sturgeon are utilizing the habitat above the former Edwards Dam, 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.

The Lockwood dam is located at the site of a natural falls (Ticonic Falls). It is not thought 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 (MDMR 2003) suggests that the adult population has grown by approximately 30% in the last twenty years. Based on this information, we believe 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 described in the Status of the Species, Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the Kennebec River 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 in the Kennebec River each year due to anthropogenic sources. 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. Despite these 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. 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 two- year construction/demolition period. As such, we expect that numbers of shortnose sturgeon in the action area will continue to be stable at high levels over the four –year duration of the proposed action.

All effects of exposure to electrical current associated with electro-fishing will be insignificant and discountable. 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 electro-fishing will not preclude any shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating, or that the fitness of any individuals will be affected. Behavioral responses are expected to be temporally and spatially limited to the immediate area and exact time when electro fishing is conducted and as such it will be limited to only a few hours per day at one of 11 discrete locations. Behavioral responses of exposed fish could range from a temporarily stun, to twitching and rolling. We have determined that any behavioral responses would have insignificant and discountable effects to listed individuals.

This action is expected to have an undetectable reduction in reproduction of shortnose sturgeon in the Kennebec River. 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.

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 River. 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.

In rare instances, it may be determined that an action does not appreciably reduce the likelihood of a species survival; however, that same action might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(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 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

8.3 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.

All effects of exposure to electrical current associated with electro-fishing will be insignificant and discountable. 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 electro-fishing will not preclude any Atlantic sturgeon from completing any essential behaviors such as resting, foraging or migrating, or that the fitness of any individuals will be affected. Behavioral responses are expected to be temporally and spatially limited to the immediate area and exact time when electro fishing is conducted and as such it will be limited to only a few hours per day at one of 11 discrete locations. Behavioral responses of exposed fish could range from a temporarily stun, to twitching and rolling. We have determined that any behavioral responses would have insignificant and discountable effects to listed sturgeon.

This action is expected to have an undetectable reduction in reproduction of 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 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.

The proposed action is not likely to reduce distribution because the action will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, or spawning grounds in the Kennebec River. 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 electro-fishing operations.

Based on the information provided above, the exposure of Atlantic 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 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; (4) and, 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.

In rare instances, it may be determined that an action does not appreciably reduce the likelihood of a species survival; however, that same action might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed 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 since it 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, there 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 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 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. 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 Atlantic 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 New York Bight DPS of Atlantic Sturgeon

The NYB DPS 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 7% of the Atlantic sturgeon in the action area to originate from the New York Bight DPS.

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.

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

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

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

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

NYB DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. A bycatch estimate provided by NEFSC indicates that approximately 376 Atlantic sturgeon die as a result of bycatch each year. 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. NYB DPS Atlantic sturgeon are killed as a result of anthropogenic activities in the Hudson River and other rivers; sources of potential mortality include vessel strikes and entrainment in dredges.

Behavioral responses are expected to be temporally and spatially limited to the immediate area and exact time when electro fishing is conducted and as such it will be limited to only a few hours per day at one of 11 discrete locations. Behavioral responses of exposed fish could range from a temporarily stun, to twitching and rolling. We have determined that any behavioral responses would have insignificant and discountable effects to listed sturgeon

The survival of any NYB DPS Atlantic sturgeon will not be affected by the proposed fish assemblage study. As such, there will be no reduction in the numbers of NYB DPS Atlantic sturgeon and no change in the status of this species or its trend. Reproductive potential of the NYB DPS is not expected to be affected in any way. As all sturgeon are anticipated to fully recover from any physiological impacts and any behavioral responses will not delay or disrupt any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, any delay in migration to the spawning grounds will be limited to minutes - to - hours and is not anticipated to impact the success of reproduction. The proposed action will also not affect the spawning grounds within the Hudson River which is one of two rivers within the NYB DPS where spawning is thought to occur. The action will also not create any barrier to pre-spawning sturgeon accessing the 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 electro-fishing operations.

Based on the information provided above, the exposure of NYB DPS Atlantic sturgeon to the effects of 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 to the fitness of any individuals and no effect on reproductive output of the NYB DPS of Atlantic sturgeon; (3) and, 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.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed 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 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 NYB DPS Atlantic sturgeon and since it 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, there 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 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. 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 the NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

9. <u>CONCLUSION</u>

After reviewing the best available information on the status of endangered and threatened species under our jurisdiction in the Kennebec River, 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 Atlantic salmon critical habitat.

10. <u>INCIDENTAL TAKE STATEMENT</u>

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. we interprets the term “harm” as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (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. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action 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.

10.1 Amount or Extent of Incidental Take of Atlantic Salmon

The proposed action has the potential to directly affect Atlantic salmon 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, no injuries are likely to be sustained. 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 are likely to be effected annually by the four-year electrofishing survey. While no injuries or mortalities to any Atlantic salmon are expected, the anticipated interaction of four Atlantic salmon 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 Amount or Extent of 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. 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 one individual shortnose sturgeon is likely to be effected annually by the four-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.

10.3 Amount or Extent of Incidental Take of Atlantic Sturgeon

The proposed action has the potential to directly affect the GOM and NYB DPS' of Atlantic 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 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 one Atlantic sturgeon from either DPS is likely to be effected annually by the four-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.

10.4 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.

10.5 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 MDMR electrofishing protocols;

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

4. 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 leave the sampling area;

5. 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;

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 (refrigerate or freeze) in accordance with Appendix B 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).

9. 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, 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 hand held net, Term and Condition 3 is necessary and appropriate to prevent the occurrence of this additional source of injury and mortality. Term and Condition 4 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. As 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, e whether the salmon was naturally reared or hatchery origin. Term and Condition 8 are required to complete the annual take reporting requirement.

11. <u>CONSERVATION RECOMMENDATIONS</u>

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, 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 recommendations:

- 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. <u>RE-INITIATION OF CONSULTATION</u>

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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14. 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 (i.e., observer on boat):

____

Species Information:

Species ____________________________________

Fork length (or total length) _______________________ Weight ________________________

Condition of specimen/description of animal

____

____

____

____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY

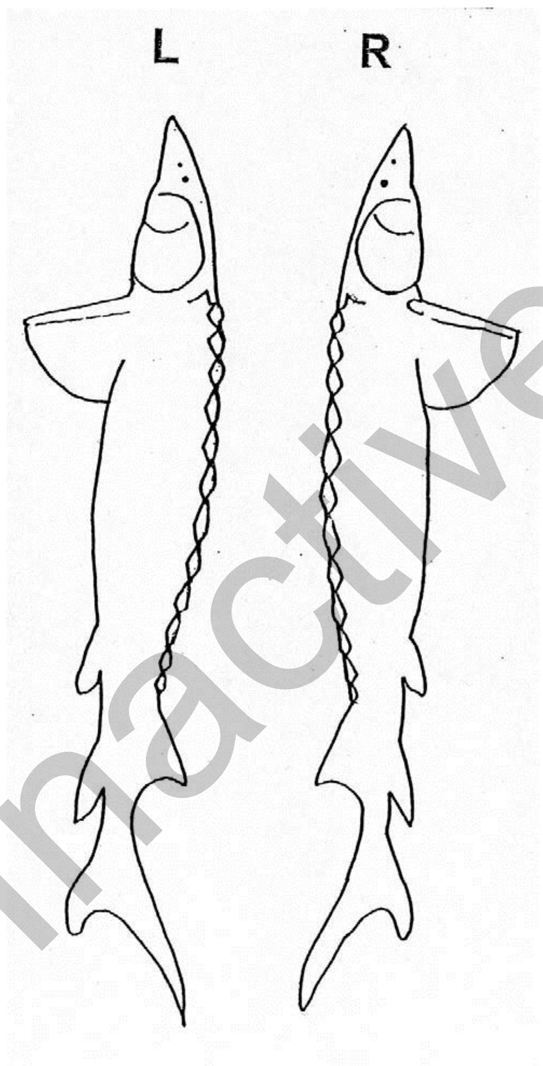
Fish tagged: YES / NO *Please record all tag numbers.* Tag # _________________

Photograph attached: YES / NO

(please label *species, date, geographic site* and *vessel name* on back of photograph)

Appendix A. Continued

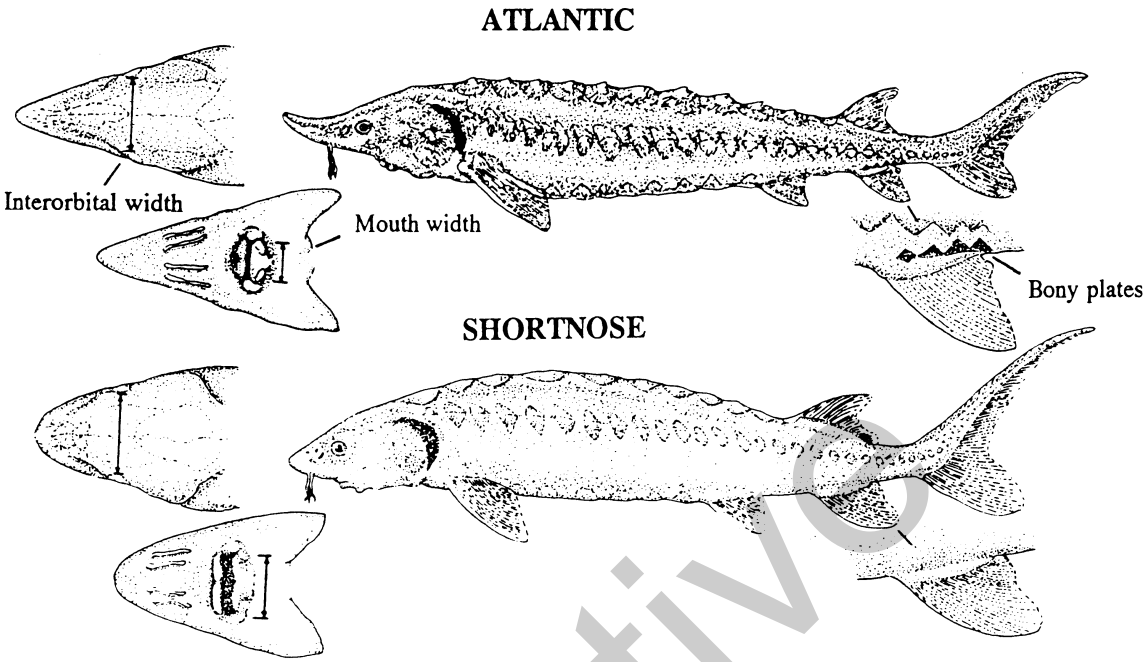
Draw wounds, abnormalities, tag locations on diagram and briefly describe below



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

* From Vecsei and Peterson, 2004

15. APPENDIX B. Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

Sending of Sample

1. Prior to sending the sample, contact Lynn Lankshear at NMFS Northeast Regional Office (978-282-8473) to report that a sample is being sent and to discuss proper shipping procedures.

2. Vials should be placed into Ziploc or similar re-sealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547