NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency:	Environmental Protection Agency, Region 1
Activity Considered:	**Environmental Protection Agency-National Rivers and Streams Assessment**
	NER-2014-11126 GARFO-2014-00020
Conducted by:	National Marine Fisheries Service Greater Atlantic Region Fisheries Office
Date Issued:	3 September 2014
Approved by:	[signature] for John Bullard

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543). This Opinion analyzes the effects to listed Atlantic salmon, Atlantic and shortnose sturgeon from conducting the proposed Environmental Protection Agency (EPA) National Rivers and Streams Assessment. We have provided an incidental take statement (ITS), pursuant to section 7(a)(2), to authorize take of Atlantic salmon that is likely to occur as a result of electrofishing activities conducted by EPA. The proposed project will provide information to better understand the ecological issues and interactions that may affect large river management and species restoration. The term of the proposed survey is July 1, 2014 through September 30, 2014.

This Opinion is based on information provided in the Biological Assessment (January 2014). A complete administrative record of this consultation will be maintained at our Maine Field Office in Orono, Maine. Formal consultation was initiated on April 21, 2014. Given the 135 day statutory timeframe for formal consultation, we anticipated that our Opinion would be issued by September 5, 2014.

1.1. Consultation History

- April 23, 2014 – NMFS received request for consultation in addition to the Biological Assessment and initiated consultation.

- May 15, 2014 – NMFS contacted EPA and Maine Department of Marine Resources to obtain additional information to coordinate sampling effort.

- May 30, 2014 – NMFS disseminated electronic files for electrofishing sites and locations received from EPA to Maine Department of Marine Resources.

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 13 and are cited directly throughout the body of the document. Primary sources of information include: 1) information provided in the Biological Assessment from EPA in their request for consultation letter dated April 21, 2014; 2) Determination of Endangered Status for the Gulf of Maine Distinct Population Segment of Atlantic salmon; Final Rule (74 FR 29345; June 19, 2009); 3) Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006); 4) Designation of Critical Habitat for Atlantic salmon Gulf of Maine Distinct Population Segment (74 FR 29300; June 19, 2009); 5) Final Recovery Plan for Shortnose Sturgeon (December, 1998); and 6) Final listing determinations for the five distinct population segments of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (77 FR 5880 and 77 FR 5914; Feb.6, 2012).

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

This section reviews 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 NMFS and the USFWS. In conducting analyses of actions under section 7 of the ESA, we take the following steps:

- Identify the action area based on the extent of the effects of the proposed action (Section 2);
- Evaluate 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);
- Evaluate the environmental baseline in the action area to biological requirements and the species' current status, as well as the status of any designated critical habitat (Section 4);
- Evaluate the relevance of climate change on environmental baseline and status of the species (Section 5);
- Determine whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 6);
- Determine and evaluate any cumulative effects within the action area (Section 7); and,
- Evaluate whether the effects of the proposed action and the status of the species, 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.

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 that define "critical habitat" and "conservation," in section 4 that describe the designation process, and in section 7 that set forth the substantive protections and procedural aspects of consultation. Although some "properly functioning" habitat parameters are generally well known in the fisheries literature (e.g., thermal tolerances), for others, the effects of any adverse impacts are considered in more qualitative terms. The analysis presented in this Opinion does not rely on the regulatory definition of "adverse modification or destruction" of critical habitat at issue in the 9th Circuit Court of Appeals case Gifford Pinchot Task Force *et al.* v. U.S. Fish and Wildlife Service, 378 F. 3d 1059 (9th Cir. 2004).

2. PROJECT DESCRIPTION AND PROPOSED ACTION

The Environmental Protection Agency (EPA) proposes to conduct fish assemblage assessments in rivers and streams with the Index of Biotic Integrity (IBI) approach, which is intended to gauge aquatic biotic responses to water quality and habitat changes. The EPA has also used a Quality Assurance Project Plan approach to develop a standardized quantitative sampling methodology to generate contemporary baseline data in study areas. Data collected during the proposed study will be used to evaluate abundance and distribution of aquatic species found in the watershed to compare with previous baseline information on the current status of these fisheries. All proposed work will be conducted between July 1, 2014 and September 30, 2014.

2.1. Covered Activities

To survey the existing population of fishes within the designated rivers and streams in New England identified below in section 3.1 of this opinion (Atlantic salmon sites in Maine -Table 1), the EPA intends to use standard electrofishing techniques. Electrofishing entails passing an electric current in the water to capture or control fish. The electric current causes fish within the effective area of the electric field to become temporarily stunned or immobilized (referred to as electrotaxis) to facilitate capture by nets (Snyder 2003). Single pass boat electro-fishing surveys will be completed on larger mainstem areas of the river along with backpack electrofishing gear on smaller streams. The identified site transects will be sampled once during the study period.

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., suckers, shad, alewives 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 in diameter down to a depth of approximately 2.5 meters. 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.

Any captured fish will be immediately placed in aerated live wells containing ambient river water. Each transects 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 during each transect, the maximum holding time for any one fish will be <15 minutes. Captured fish will be identified to species, measured, enumerated and released alive. In the event that any adult Atlantic salmon, Atlantic sturgeon and shortnose sturgeon are observed to be incidentally stunned during sampling, the researchers have stated that sampling will be immediately suspended until fish are out of the immediate survey area. NMFS will be contacted within 24 hours should this occur.

2.2. Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area (project area) involved in the proposed action" (50 CFR 402.02). The action area must encompass all areas where the direct or indirect effects of the proposed action would affect listed species or critical habitat. 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 the jurisdiction of NMFS. NMFS listed Atlantic salmon, Atlantic sturgeon and shortnose sturgeon are known to occur within the study area of the proposed survey. As explained above, the action will involve electrofishing mainstem rivers by running transects along 1 km reaches of shoreline. Each transect will result in an electric field 4.5 meters wide, 2.5 meters deep and incrementally up to1 km long. Sampling small tributaries will involve using a backpack electrofishing unit that will produce a much smaller electric field. Thus, the action area is defined as the proposed sampling site in areas where the electric field may occur. The proposed action is not expected to have any direct or indirect effects to listed species outside of the areas where electric current will be experienced.

3. LISTED SPECIES IN THE ACTION AREA

3.1 SPECIES THAT ARE NOT LIKELY TO BE ADVERSELY AFFECTED BY THE PROPOSED ACTION

Fish

Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered
GOM DPS of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Threatened
NYB DPS of Atlantic sturgeon	Endangered
CB DPS of Atlantic sturgeon	Endangered
SA DPS of Atlantic Sturgeon	Endangered

The range of federally listed Atlantic sturgeon and shortnose sturgeon includes coastal rivers, estuaries, and marine waters within the Gulf of Maine and along the Atlantic coast. We have determined that neither shortnose sturgeon nor any of the five distinct population segments of Atlantic sturgeon will likely occur in the small wadeable tributary streams above mainstem dams where electrofishing work will be conducted (Table 1). We have also determined that if sturgeon are present during certain times of the year in the lower portions of the mainstem rivers (identified below), these individuals are not likely to be adversely affected from the electrofishing activities.

We have reviewed the list of proposed sampling sites and have identified the following sites where listed sturgeon may occur:

- NYRM-1004, Hudson River near Menands (RM 150)
- NYR9-0907, Hudson River near Coeymans (RM 135);
- NYRM-1008, Hudson River near Germantown (RM 112);
- NYR9-0916, Hudson River near Saugherties Lighthouse (RM 105);
- MAR9-0903, Connecticut River near Montague (RM 120);
- MARM-1002, Connecticut River near Hatfield (RM 100);
- CTRM-1003, Connecticut River near Thompsonville (RM 64);
- CTRM-1002, Connecticut River near Rocky Hill State Park (RM 36);
- CTRM-1001, Connecticut River near Saybrook (RM 18); and,

- MER9-0907, Kennebec River near Vassalboro (RM 54).

We have determined that all effects of the proposed action on shortnose and Atlantic sturgeon will be insignificant and discountable. We do not anticipate any incidental take of shortnose or Atlantic from any of the activities considered in this Opinion. Our supporting analysis is presented below.

3.1.1 Shortnose sturgeon in the action area

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

Hudson River Sites

Shortnose sturgeon occur in the Hudson River from upper Staten Island (RM -3) to the Troy Dam (RM 155) (Bain *et al.* 2000, ASA 2008). The most recent abundance estimates of shortnose sturgeon in the Hudson River range from a low of 25,255 to a high of 80,026; though 61,057 is the abundance estimate from the dataset and modeling exercise that is typically used (Bain *et al.* 2000). This estimate is based on mark-recapture sampling carried out from 1994-1997.

Shortnose sturgeon occur in the reach where the NYR9-0907 and NYRM-1004 sampling sites are located during the spring spawning period. In approximately late March through mid-April, when water temperatures are sustained at 8°-9° C (46.4-48.2°F) for several days[1], reproductively active adults begin their migration upstream to the spawning grounds that extend from below the Federal Dam at Troy to about Coeymans, NY (RM 152-131) (Dovel *et al.* 1992)). Spawning typically occurs at water temperatures between 10 and 18°C (50-64.4°F) after which adults disperse quickly down river into their summer range. In the Hudson River, temperatures (as measured at the USGS gage in Albany) are typically between 8 and 18°C for a 4-6 week period between early April and late May each year. Dovel *et al.* (1992) reported that spawning fish tagged at Troy were recaptured in Haverstraw Bay (RM 34-40) in early June.

Shortnose sturgeon eggs adhere to solid objects on the river bottom (Buckley and Kynard 1981; Taubert 1980). Eggs and larvae are expected to remain within the vicinity of the spawning grounds for approximately four weeks post spawning (i.e., at latest through mid-June). Larvae gradually disperse downstream after hatching, entering the tidal river (Hoff *et al.* 1988) and concentrating in deep channel habitat (Taubert and Dadswell 1980; Bath *et al.* 1981; Kieffer and Kynard 1993; Dovel *et al.* 1992).

Based on the best available data, we expect adult shortnose sturgeon to occur near the RM 150 and RM 135 transects when spawning. Depending on annual variations in water temperature, adults are expected in this area for a 4-6 week period between early April and late-May. We expect early life stages to be present in the action area for approximately four weeks after spawning ends. Therefore, we expect early life stages near the RM 150 and RM 135 sampling sites from late April through June which is outside of the time of year the proposed action will

[1] USGS gage in Albany (gage no. 01359139). Information available at: http://waterdata.usgs.gov/usa/nwis/uv?01359139

take place.

The broad summer range occupied by adult shortnose sturgeon extends from approximately RM 23.5-110. During a mark recapture study conducted from 1976-1978, Dovel *et al.* (1979) captured larvae near Hudson, NY (RM 117) and young of the year were captured further south near Germantown (RM 106). Electrofishing will occur at the RM112 and RM 105 sites between July 1 and October 15. During this time of year, juvenile and adult shortnose sturgeon are likely to be present in those river reaches.

Connecticut River
Currently, the Connecticut River population of shortnose sturgeon is separated into an upstream and downstream segment bisected by the Holyoke Dam (RM 97). The upstream population ranges from the Turners Falls Dam to the Holyoke Dam; the downstream segment extends from the Holyoke Dam to the confluence with Long Island Sound. Shortnose sturgeon spawn near Montague, and adults and early life stages are expected to be near the RM 120 sampling site between April 15 and June 22. Shortnose sturgeon are distributed throughout the rest of the river year-round. Shortnose sturgeon are likely to be in the reaches with the four other sampling sites during the time of year sampling will occur.

Kennebec River Sites
Shortnose sturgeon are present in the Kennebec River from the mouth to the Lockwood Dam (RM 61). A Schnabel estimate using tagging and recapture data from 1998 - 2000 indicates a population estimate of 9,488 (95% CI, 6,942 to 13,358) for the estuarine complex (Squiers 2003). The average density of adult shortnose sturgeon/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). 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. Sampling in the Kennebec River is proposed at RM 54. The primary spawning site is located between RM 36-44. Spawning is also suspected to occur further upstream but has not yet been confirmed. Spawning in the Kennebec River takes place from late April – mid May.

As reported in SSSRT 2010, tracking data and gillnet studies indicate that the majority of shortnose sturgeon feed in the Bath region of the Kennebec River (RM 10-18) from mid-April through late November and early December. Sturgeon then migrate upriver to overwinter in Merrymeeting Bay. Although the major concentration of shortnose sturgeon is found in the Bath region which includes the Sasanoa River, shortnose sturgeon are also found in Monstweag Bay in the lower Sheepscot River and in Merrymeeting Bay (RM 18-26) located upriver of Bath. Based on limited gillnetting data and telemetry data, it appears that shortnose sturgeon occasionally make forays upriver to the Augusta/Gardiner (RM 37-43) area during the summer months.

Based on the available information, shortnose sturgeon are unlikely to occur in the area where sampling will occur during the July-October sampling period.

3.1.2 Atlantic sturgeon in the action area

Five DPSs of Atlantic sturgeon are listed under the ESA. These are: the Gulf of Maine (GOM), New York Bight (NYB), Chesapeake Bay (CB), Carolina, and South Atlantic (SA) DPSs). The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered, and the Gulf of Maine DPS is listed as threatened. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings (77 FR 5880 and 77 FR 5914 Feb. 16, 2012).

As described below, depending on the sample site individuals originating from a number of the listed DPSs are likely to be present.

Hudson River Sites

The range of Atlantic sturgeon in the Hudson River extends from New York Harbor to the Troy Dam (Bain *et al.* 2000; Hattala and Fox, personal communication 2014). There is no current estimate of the number of Atlantic sturgeon present in the Hudson River or the total size of the New York Bight DPS.

Until recently, we did not expect Atlantic sturgeon to occur upstream of RM 105. In April 2014, we received information from researchers working in the Hudson River which, through detection of tagged individuals on a receiver array, confirms the presence of adult Atlantic sturgeon upstream of RM 120 from late April – early July (Dewayne Fox, DSU and Kathy Hattala, NYDEC, personal communication April 2014). At this time, the available data are limited to three fish comprised of two males in spawning condition and an assumed male. However, given the time of year, the reproductive conditions of the fish, and the known presence of suitable spawning substrate upstream of RM 120, this strongly suggests that Atlantic sturgeon are spawning further upstream than previously suspected. Two of the fish had moved downstream past RM 95 by June 15 while the other remained above RM 95 until late July.

Based on the best available data, we expect adult Atlantic sturgeon to occur near the two upstream Hudson River sampling sites between late April and early July; individual adult Atlantic sturgeon may also be near the RM 112 and RM 105 sites from late April through the end of July. We expect early life stages to be present in the area for approximately four weeks after spawning ends. Therefore, we expect early life stages from late April through the end of July, after which larvae will be further downstream. We expect all Atlantic sturgeon in this area to have originated from the New York Bight DPS. Depending on the exact timing of spawning activities and sampling, adults and/or early life stages may be present in the reaches where sampling occurs.

Connecticut River

Atlantic sturgeon do not occur upstream of the Holyoke Dam (RM 97). Therefore, no Atlantic sturgeon will be exposed to sampling activities in Montague or Hatfield. The Connecticut River does not currently support a spawning population of Atlantic sturgeon; however, subadult and adult Atlantic sturgeon occur in the lower river and estuary during the summer. Atlantic sturgeon may be present in the RM 64, 36 and 18 sampling sites. These Atlantic sturgeon could belong to any of the 5 DPSs.

Kennebec River
Atlantic sturgeon occur in the Kennebec River from the mouth to the Lockwood Dam. Spawning occurs in freshwater and depending on annual water temperature is expected to occur over several weeks in May-June. During the July – October period when sampling will occur, Atlantic sturgeon may be present in the RM 54 reach. These sturgeon are likely to originate from the GOM or NYB DPS (see Damon-Randall *et al.* 2012).

3.1.3 Effects of the Action on shortnose and Atlantic sturgeon
As explained above, a total of 10 sites will be sampled in areas where shortnose or Atlantic sturgeon may be present. Each site will be sampled by completing a single electrofishing transect. Shortnose sturgeon are likely to be present near six of these sites in the July – October time period (Hudson RM 112 and 105; CT RM 100, 64, 36, 18) and Atlantic sturgeon are likely to be present near 8 of these sites (Hudson RM 150, 135, CT RM 64, 26, 18, Kennebec RM 54).

There are several factors that make interactions with shortnose and Atlantic sturgeon extremely unlikely to occur. In order to be directly affected by the sampling, an individual sturgeon would need to be close enough to the electrofishing boat to be exposed to the electric current. At any given time in the 45 minute survey, the electric current extends across an area only 4.5 meters wide and 2.5 meters deep. Electrofishing will largely be contained along the shallow margins of the shoreline. In some areas, particularly those with vegetated mudflats or shellfish beds, sturgeon occur in the nearshore shallows while foraging. Electrofishing will not occur in areas with vegetated mudflats or shellfish beds; the absence of the features that make shallow, nearshore areas suitable habitat for foraging sturgeon are absent from the areas where electrofishing will occur. The nearshore, shallow location of the transects combined with the small effective range of the electric current, make it extremely unlikely that any shortnose or Atlantic sturgeon will be exposed to the electric current. The likelihood of interactions is further reduced by the short duration of each sampling event (45 minutes) and the small number of sampling events. These rivers were sampled following an identical methodology in 2008 and 2009, and there were no interactions with sturgeon. Based on the above information, the potential for interactions between the electrofishing gear and shortnose and Atlantic sturgeon during this survey is discountable.

The proposed sampling is not expected to kill or destroy any potential sturgeon forage items. As the electric current is temporary and will be applied in areas where we do not expect sturgeon to forage, there are no impacts to the forage base of sturgeon or to water quality that would affect the use of the sampled areas by sturgeon.

Based on the analysis presented above, all effects to shortnose sturgeon and Atlantic sturgeon originating from any of the five DPSs will be insignificant or discountable. Therefore, the proposed action is not likely to adversely affect these species. No incidental take of shortnose or Atlantic sturgeon is anticipated. These species will not be considered further in this analysis.

3.2 STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

We have determined that the following endangered or threatened species are likely to be adversely affected by the proposed action:

Fish
Gulf of Maine DPS of Atlantic salmon (*Salmo salar*) Endangered

3.2.1 Atlantic salmon in the action area

The implementation of the EPA National Rivers and Streams Assessment survey could affect stream and river habitat throughout the Downeast Coastal, Merrymeeting Bay, and Penobscot Bay SHRUs (Figure 2). As explained above, the action will involve electrofishing in the mainstem portion of the river by running transects along 1 km reaches of shoreline in some of the larger drainages (Penobscot, Kennebec, Sheepscot, Machias) and in small wadeable tributaries (Table 1).

The sites within the GOM DPS are identified in Table 1 below. It is anticipated that most sites being sampled for the National Rivers and Streams Assessment program will occur within small (< 10 meters wide) freshwater tributaries; however, it is also possible that some sites could occur within tidal habitat in the lower main stem river. There are eleven base sites and another six alternative or over-sample sites that could contain juvenile Atlantic salmon (Table 1). In general, the action area related to an individual electrofishing site will include some or all of the following:

1) An area of stream that is temporarily disturbed by personnel during electrofishing activities to capture and enumerate all fish within the designated site;

2) An area within and downstream of the site location that would experience a temporary increase in sediment from in-stream electrofishing activities;

3) An area of river where electric current is generated to facilitate fish collection, including the use of boat electrofishing equipment and backpack electrofishing gear in wadeable streams.

Critical Habitat
Designated for the Gulf of Maine DPS of Atlantic salmon (Figure 1).

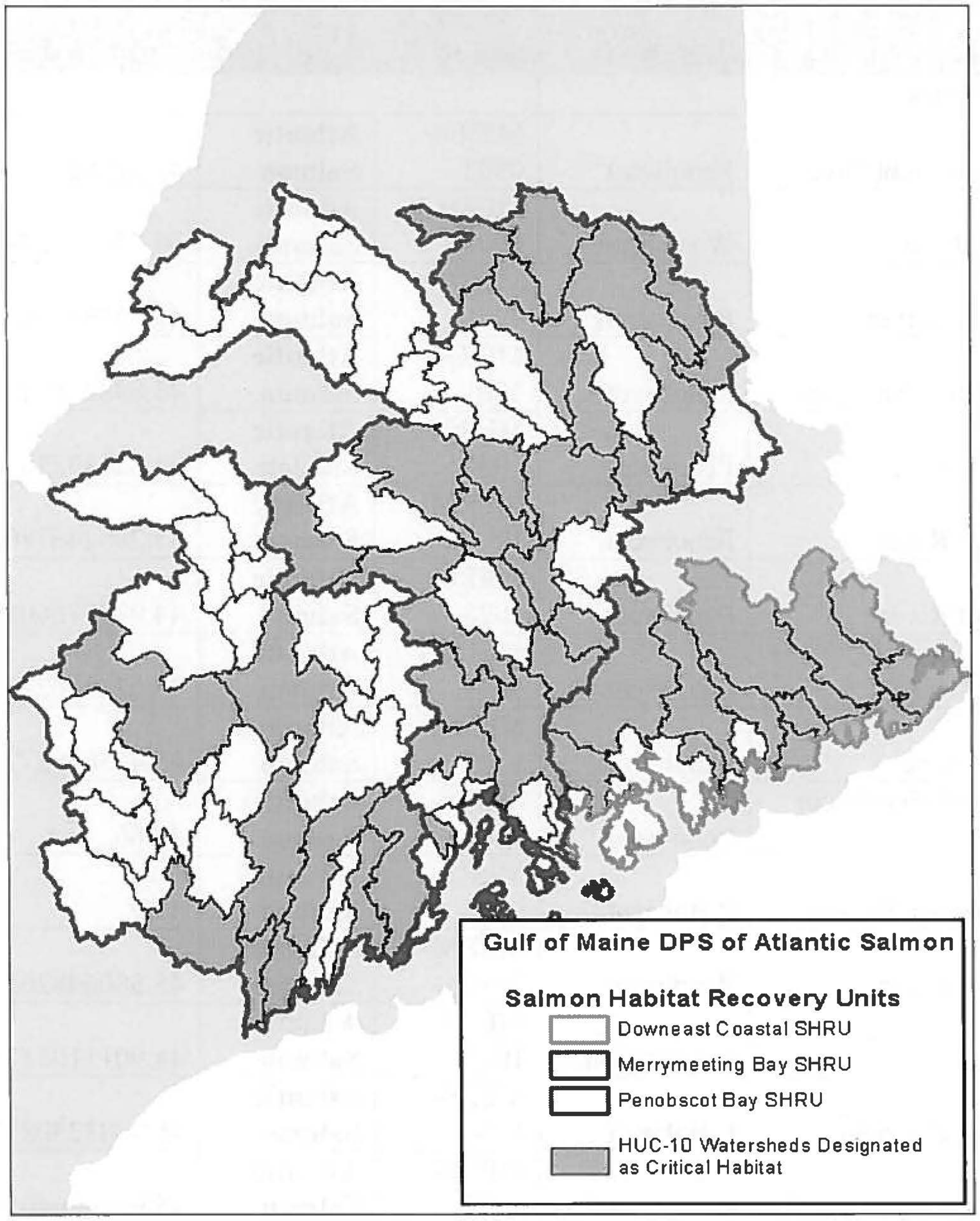

Figure 1. Gulf of Maine DPS of Atlantic salmon habitat recovery units and designated critical habitat.

Table 1. EPA designated electrofishing sites with Atlantic salmon

Site Name	County	Site ID	ESA Species	Latitude	Longitude
BASE SITES					
E. Br. Penobscot River	Penobscot	MER9-0903	**Atlantic Salmon**	45.87866621520	-68.62034334480
Machias River	Washington	MER9-0904	**Atlantic Salmon**	44.73737623480	-67.54984267770
Piscataquis River	Piscataquis	MER9-0906	**Atlantic Salmon**	45.25733170570	-68.94965872110
E. Br. Penobscot River	Penobscot	MERM-1001	**Atlantic Salmon**	45.89866814380	-68.61411192240
Penobscot River	Penobscot	MERM-1002	**Atlantic Salmon**	44.82133230000	-68.70376482870
Penobscot River	Penobscot	MERM-1006	**Atlantic Salmon**	45.20824674000	-68.63326099700
Penobscot River	Penobscot	MERO-1028	**Atlantic Salmon**	44.97087860880	-68.65280575400
Seboeis River	Penobscot	MELS-1051	**Atlantic Salmon**	46.02430822230	-68.60342499340
Gordon Brook	Penobscot	MESS-1109	**Atlantic Salmon**	45.47867027710	-68.21031490380
East Branch Penobscot River	Penobscot	MERF-0006	**Atlantic Salmon**	45.86	-68.62
Wassataquoik Stream	Penobscot	MERF-0005	**Atlantic Salmon**	45.9	-68.64
Penobscot River	Penobscot	MERM-1010	**Atlantic Salmon**	45.58064826550	-68.43633298130
Old Stream	Washington	MELS-1054	**Atlantic Salmon**	44.90111031790	-67.70937702800
W. Br. Dead Stream	Penobscot	MELS-1056	**Atlantic Salmon**	45.08032308570	-68.88124963770
E. Br. Mattawamkeag R.	Aroostook	MELS-1057	**Atlantic Salmon**	45.98669646580	-68.09986439350
Trib to Little Machias River	Aroostook	MESS-1110	**Atlantic Salmon**	46.66107902080	-68.45575937550
Norcross Brook	Piscataquis	MESS-1111	**Atlantic Salmon**	45.82504753570	-69.60821782920
Trib to Sheepscot River	Lincoln	MESS-1112	**Atlantic Salmon**	43.87820132850	-69.67827995430
Hill Brook	Penobscot	MESS-1113	**Atlantic Salmon**	44.74913213990	-69.01391578350

This section will focus on the status of Atlantic salmon and critical habitat within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

3.2.2 Gulf of Maine DPS of Atlantic Salmon

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

The GOM DPS of anadromous Atlantic salmon was initially listed jointly by the USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). In 2009, the Services finalized an expanded listing of Atlantic salmon as an endangered species (74 FR 29344; June 19, 2009).

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

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

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

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

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

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

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). Fry actively defend territories, and this behavior becomes more pronounced at the parr stage (Allen 1940, Kalleberg 1958, Danie *et al.* 1984).

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 occurs throughout the year, but may be quite limited in the winter (Cunjak 1988, Heggenes 1990); however, movement in the winter does occur (Hiscock *et al.* 2002) and is often necessary, as ice formation reduces total habitat availability (Whalen *et al.*1999). Parr have been documented using riverine, lake, and estuarine habitats; incorporating opportunistic and active feeding strategies; defending territories from competitors including other parr; and working together in small schools to actively pursue prey (Gibson 1993, Marschall *et al.*1998, Pepper 1976, Pepper *et al.* 1984, Hutchings 1986, Erkinaro *et al.* 1998, Halvorsen and Svenning 2000, O'Connell and Ash 1993, Erkinaro *et al.* 1995, Dempson *et al.* 1996, Klemetsen *et al.* 2003).

In Maine, most parr remain in the river for two to three years before undergoing smoltification (90 percent or more) with the balance remaining another one to three years (USASAC 2005). Alternatively, some male parr may not leave the fresh water environments or go through smoltification; these fish may also become sexually mature and may participate in spawning with sea-run adult females and are referred to as "precocious parr." Typically, during a parr's second or third spring (age 1 or age 2, respectively), when it has grown to 12.5 to 15 cm in length, a series of physiological, morphological, and behavioral changes occur during the smoltification process (Schaffer and Elson 1975). The physiological changes that occur during smoltification prepare the fish for the dramatic change in osmoregulatory needs that come with the transition from a fresh to a salt water habitat (Ruggles 1980, Bley 1987, McCormick and Saunders 1987, McCormick *et al.* 1998). These changes also affect visible attributes; the body becomes more streamlined and silvery with fading parr markings and lengthening and darkening of the margins of the fins producing a pronounced fork in the tail. The transition of smolts into seawater is usually gradual as they pass through a zone of fresh and saltwater mixing that typically occurs in a river's estuary. During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and various predator assemblages.

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

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 during their first spring at sea (Reddin 1985, Dutil and Coutu 1988, Ritter 1989, Reddin and Friedland 1993, Friedland *et al.* 1999). Later in the season, 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°N and 58°N (Reddin 1985, Reddin and Short 1991, Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish or MSW) and also includes immature salmon from both North American and European stocks (Reddin 1988, Reddin *et al.* 1988). According to research conducted in 1993 by Freidland *et al.*, the distribution of winter habitat in the Labrador Sea and Denmark Strait may be influencing survival of migrating adults during their first winter at sea and may be a limiting factor for North American populations (Friedland *et al.* 1993).

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.

3.2.3 Status and Trends of Atlantic Salmon in the GOM DPS

The abundance of Atlantic salmon within the range of the GOM DPS has been generally declining since the 1800s (Fay *et al.* 2006). Data sets tracking adult abundance are not available throughout this entire time period; however, a comprehensive time series of adult returns to the GOM DPS dating back to 1967 exists (Fay *et al.* 2006, USASAC 2001-2012) (Figure 2). 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 1980s, adult returns of salmon in the GOM DPS declined steadily since early 1990s; however, more recently there have been some years with encouraging increases of adult returns particularly in 2009 and 2011, unfortunately, 2012 and 2013 has continued the downward trend (Figure 2). The population growth observed in the 1980s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH that was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed more recently.

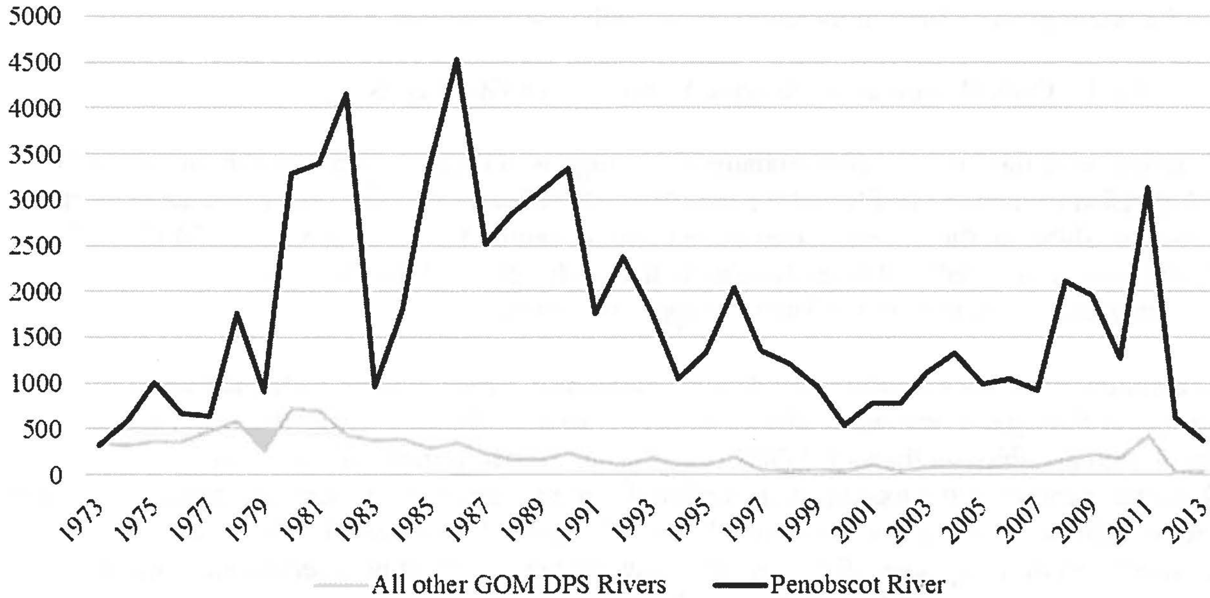

Figure 2. Adult returns to the GOM DPS Rivers between 1973 and 2013 (Fay *et al.* 2006, USASAC 2001-2014).

Adult returns to the GOM DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Low abundances of both hatchery-origin and naturally-reared adult salmon returns to Maine demonstrate continued poor marine survival. Further, the majority of all adults in the GOM DPS return to a single river, the Penobscot, these returns accounted for 91 percent of all adult returns to the GOM DPS between 2000 and 2013. The majority of the adults returning to the GOM DPS are of hatchery origin because the natural population is maintained through hatchery supplementation. For example, of the 3,125 adult returns to the Penobscot in 2011, the majority are the result of smolt stocking; and only a small portion were naturally-reared. In the GOM DPS, nearly all of the hatchery-reared smolts are released into the Penobscot River, more recently, efforts are underway to expand smolt stocking in the Downeast SHRU to increase adult returns.

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

In conclusion, the abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of naturally-reared adult fish returning to natal rivers to spawn is very small (approximately 6% over the last ten years). 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 significantly contributed to an increase in the overall abundance of naturally reared adults returning to the rivers and stream within the GOM DPS. Accordingly, continued reliance on the conservation hatchery program could prevent extinction but will not allow recovery of the GOM DPS, which must be accomplished through increases in naturally reared salmon.

3.2.4 Critical Habitat for Atlantic Salmon in the GOM DPS

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 2). 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 complex life cycles exhibited by Atlantic salmon give rise to complex habitat needs, particularly during the freshwater phase (Fay *et al.* 2006). Therefore, the status of Atlantic salmon critical habitat in the GOM DPS is important for two primary reasons: a) because it affects the viability of the listed species within the action area at the time of the consultation; and b) because those habitat areas designated "critical" provide PCEs essential for the conservation (i.e., recovery) of the species. For example, spawning gravel 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 freshwater but instead rely on limited energy stores to migrate, mature, and spawn. Like juveniles, they also require cool water and places to rest and hide from predators. During all life stages, Atlantic salmon require cool water that is free of contaminants. They also need migratory corridors with adequate passage conditions (timing, water quality, and water quantity) to allow access to the various habitats required to complete their life cycle.

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[2]). We chose not to separate 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

---

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

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.

The physical and biological features of the two PCEs for Atlantic salmon critical habitat are as follows:

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 in-stream 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 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, the ones that may require 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, Penobscot Bay, and Merrymeeting Bay. The SHRU delineations were designed 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, is 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 Coastal SHRU has enough habitat units available within the occupied range that, in a restored state (*e.g.* improved fish passage or improved habitat quality), it could satisfy recovery objectives as described in the final rule for critical habitat (74 FR 29300; June 19, 2009). Certain tribal and military lands within the Downeast Coastal SHRU are excluded from critical habitat designation.

Penobscot Bay SHRU

The Penobscot Bay 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 Bay SHRU are also excluded from critical habitat designation.

Merrymeeting Bay SHRU

The Merrymeeting Bay SHRU drains approximately 2,691,814 hectares of land (6,651,620 acres) and contains approximately 339,182 units of spawning and rearing habitat for Atlantic salmon located among approximately 5,950 kilometers 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 critical habitat designation for the GOM DPS includes 45 specific areas occupied by Atlantic salmon that comprise approximately 19,571 kilometers of perennial river, stream, and estuary habitat and 799 square kilometers 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 kilometers of river, stream, and estuary habitat and 100 square kilometers of lake habitat have been excluded from critical habitat pursuant to section 4(b)(2) of the ESA.

Critical Habitat

Sites for migration and sites for spawning and rearing are likely to be present in the action area. To facilitate and standardize determinations of effect for section 7 consultations involving Atlantic salmon critical habitat, we developed the "Matrix of Essential Features for Designated Atlantic Salmon Critical Habitat in the GOM DPS" (Table 3). 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. Since we do not have specific information on the status of the critical habitat in the vicinity of each project, we have used this matrix along with knowledge of the characteristics of these systems to determine that several essential features to Atlantic salmon in the action area likely have limited function or else are not properly functioning currently (Table 4).

Table 3. Matrix of Primary Constituent Elements (PCEs) and essential features for assessing the environmental baseline of 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° to 10°C	often between 7° to 10°C	always < 7° or > 10°C
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°C and 7.2°C, averages nearly 6oC from fertilization to eye pigmentation	averages < 4oC, or 8 to 10°C from fertilization to eye pigmentation	>10°C from fertilization to eye pigmentation
D.O.	at saturation	7-8 mg/L	< 7 mg/L
pH	> 6.0	6 - 4.5	< 4.5
Depth	5.3-15cm	NA	<5.3 or >15cm
Velocity	4 – 15cm/sec.	NA	<4 or > 15cm/sec.

Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

	Conservation Status Baseline		
PCE Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
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° to 19°C	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

	Conservation Status Baseline		
PCE Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
D) Adult migration: (April 15th- December 14th)			

Velocity	30 cm/sec to 125 cm/sec	In areas where water velocity exceeds 125 cm/sec adult salmon require resting areas with a velocity of < 61 cm/s	sustained speeds > 61 cm/sec and maximum speed > 667 cm/sec
D.O.	> 5mg/L	4.5-5.0 mg/l	< 4.5mg/L
Temperature	14 – 20°C	temperatures sometimes exceed 20oC but remain below 23°C.	> 23°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°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 4. The assumed condition 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	Adult, juvenile, smolt	Freshwater migration	Upstream passage delays and inefficiencies limit access to spawning habitat. Poor downstream passage causes direct and delayed mortality of smolts and kelts.	Adult abundance and productivity,
Habitat Elements, Channel Dynamics, Watershed Condition	Adult, incubating eggs, juvenile, smolt	Freshwater migration, spawning, and rearing	Anthropogenic activities degrade spawning and rearing habitat, limit productivity, and delay migrations.	Adult abundance and productivity Juvenile growth rate
Water Quality	Adult, juvenile, incubating eggs	Freshwater spawning and rearing	Anthropogenic activities (road crossings) degrade spawning and rearing habitat.	Adult abundance and productivity Juvenile growth rate

3.3 Factors Affecting Atlantic salmon in the Action Area

3.3.1 Dams

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.

The Gulf of Maine from Cape Cod, Massachusetts to the St. Croix River in Eastern Maine contains 4,867 dams within the U.S.; 782 of which are in Maine (GMCME 2010)[3]. The GOM DPS contains 83 dams that are regulated by FERC that generally occur on larger tributaries or on the mainstem rivers (USACE 2005), and approximately 392 dams that are not regulated by FERC that generally occur on smaller tributaries and not on larger rivers (NOAA 2010). The non-FERC regulated dams range from small mill dams to larger dams owned by state, federal, and non-federal entities and include dilapidated mill dams, reservoir dams, and water level management structures constructed of stone, earth, timber, and concrete or some combination of these materials (Kleinschmidt Associates 2010). As with many old dams, fish passage structures are generally not present or may be in disrepair (Kleinschmidt Associates 2010), which typically results in impaired and very limited fish passage during differing flow conditions.

Fish Passage

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

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

Hydroelectric dams can cause injury or mortality to juvenile salmon that attempt to pass the projects as they migrate downstream to the estuary. Fish can become injured or killed by becoming entrained while passing through turbines, or by becoming impinged on the screen or

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

trash rack at the intake (Fay *et al.* 2006). Both entrainment and impingement can result in mortality as well as prevent fish passage. Although entrainment and impingement are not significant factors at non-hydroelectric dams, injury and mortality of Atlantic salmon smolts and kelts is still expected due to downstream passage over dam spillways. Based on field trials assessing fish passage over spillways at five hydroelectric dams, 97.1% of smolts are likely to survive passage via spillage (Normandeau Associates, Inc. 2011). Similarly, Alden Research Laboratory (Alden) (2012) estimated 3% mortality due to spillway passage at all the mainstem hydroelectric projects on the Penobscot River.

Migratory Delay

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

Delays to migration that could occur as a result of a road culvert or dams can individually and cumulatively, affect an individual's ability to access suitable spawning habitat within the narrow window when temperature and flow conditions in the river are suitable for migration. In addition, delays in migration can cause over-ripening of eggs, which can lead to increased chance of egg retention, and reduced egg viability in pre-spawn female salmonids (deGaudemar and Beall 1998). It is not known what level of delay at each obstruction would significantly affect a migrant's ability to access suitable spawning habitat, as it would be different for each individual and tributary, and would vary from year to year depending on environmental conditions. Accordingly, we believe that 48 hours provide adequate opportunity for pre-spawn adult Atlantic salmon to locate and utilize well-designed upstream fishways without leading to deleterious effects to the spawning success of the individual.

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

Delayed Effects of Downstream Passage

In addition to direct mortality sustained by Atlantic salmon at dams, Atlantic salmon in the GOM

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

Budy *et al.* (2002) examined the influence of hydrosystem experience on estuarine and early ocean survival rates of juvenile salmonids migrating from the Snake River to test the hypothesis that some of the mortality that occurs after downstream migrants leave a river system may be due to cumulative effects of stress and injury associated with multiple dam passages. The primary factors leading to hydrosystem stress (and subsequent delayed mortality) cited by Budy *et al.* (2002) were dam passage (turbines, spillways, bypass systems), migration conditions (e.g., flow, temperature), and collection and transport around dams, all of which could lead to increased predation, greater vulnerability to disease, and reduced fitness associated with compromised energetic and physiological condition. In addition to linking hydrosystem experience to delayed mortality, Budy *et al.* (2002) cited evidence from mark-recapture studies that demonstrated differences in delayed mortality among passage routes. They concluded that passage over spillways was the least stressful route for outmigrating smolts as it is the route most similar to a natural river. Compared to other routes, passage over spillways leads to fewer occurrences of migratory delay, mechanical injury, and predation (Budy *et al.* 2002).

More recent studies have corroborated the indirect evidence for hydrosystem delayed mortality presented by Budy *et al.* (2002) and provided data on the effects of in-river and marine environmental conditions (Schaller and Petrosky 2007, Haeseker *et al.* 2012). Based on an evaluation of historical tagging data describing spatial and temporal mortality patterns of downstream migrants, Schaller and Petrosky (2007) concluded that delayed mortality of Snake River chinook salmon was evident and that it did not diminish with more favorable oceanic and climatic conditions. Estimates of delayed mortality reported in this study ranged from 0.75 to 0.95 (mean = 0.81) for the study years of 1991-1998 and 0.06 to 0.98 (mean = 0.64) for the period of 1975-1990. Haeseker *et al.* (2012) assessed the effects of environmental conditions experienced in freshwater and the marine environment on delayed mortality of Snake River chinook salmon and steelhead trout. This study examined seasonal and life-stage-specific survival rates of both species and analyzed the influence of environmental factors (freshwater: river flow spilled and water transit time; marine: spring upwelling, Pacific Decadal Oscillation, sea surface temperatures). Haeseker *et al.* (2012) found that both the percentage of river flow spilled and water transit time influenced in-river and estuarine/marine survival rates, whereas the Pacific Decadal Oscillation index was the most important factor influencing variation in marine and cumulative smolt-to-adult survival of both species. Also, freshwater and marine survival rates were shown to be correlated, demonstrating a relation between hydrosystem experience on estuarine and marine survival. The studies described above clearly support the delayed-mortality hypothesis proposed by Budy *et al.* (2002). However, only one of the studies quantified delayed mortality, and the estimates varied considerably.

Although delayed mortality following passage through a hydrosystem has been demonstrated by the studies discussed above, effectively quantifying such losses remains difficult, mainly because of practical limitations in directly measuring mortality after fish have left a river system (i.e., during time spent in estuaries and the marine environment). Evaluations of delayed mortality have generally produced indirect evidence to support the link between hydro-system experience and estuary and marine survival rates (and smolt-to-adult returns). In fact, in a review of delayed mortality experienced by Columbia River salmon, ISAB (2007) recommended that attempts should not be made to provide direct estimates of absolute delayed mortality, concluding that measuring such mortality relative to a dam-less reference was not possible. Alternatively, it was suggested that the focus should be on estimating total mortality of in-river fish, which was considered more critical to the recovery of listed salmonids. Consequently, it is difficult to draw absolute or quantifiable inferences from the Columbia River studies to other river systems beyond the simple conclusion that delayed mortality likely occurs for most anadromous salmonid populations. Additionally, although there is evidence of differential mortality between upper and lower river smolts in the Columbia River basin (Schaller and Petrosky 2007), data are not available for estimating a cumulative mortality rate based on the number of dams passed by downstream migrants.

3.3.2 Predation

Smallmouth bass and chain pickerel are each important predators of Atlantic salmon within the range of the GOM DPS (Fay *et al.* 2006). Smallmouth bass are a warm-water species whose range now extends through north-central Maine and well into New Brunswick (Jackson 2002).

Smallmouth bass likely feed on fry and parr though little quantitative information exists regarding the extent of bass predation upon salmon fry and parr. Smallmouth bass are important predators of smolts in main stem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993).

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

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

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

3.3.3 Contaminants and Water Quality

Pollutants discharged from point sources affect water quality within the action area of this consultation. Common point sources of pollutants include publicly operated waste treatment facilities, overboard discharges (OBD), and industrial sites and discharges. The Maine Department of Environmental Protection (DEP) issues permits under the National Pollutant Discharge Elimination System (NPDES) for point source discharges. Conditions and permit limits are set to maintain the existing water quality classification. Generally, the impacts of point source pollution are greater in the larger rivers of the GOM DPS. The DEP has a schedule for preparing a number of Total Maximum Daily Load (TMDL) analyses for rivers and streams within the GOM DPS. TMDLs allocate a waste load for a particular pollutant for impaired waterbodies.

3.4 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.

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 USFWS and NMFS 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. These are the following:

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

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
- Depleted diadromous fish communities

- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon
- Poaching of adults in DPS rivers
- Conservation hatchery program (potential for artificial selection/domestication)
- Sedimentation of spawning and rearing habitat
- Water extraction

Fay *et al.* (2006) examined each of the five statutory ESA listing factors and determined that each of the five listing factors is at least partly responsible for the present low abundance of the 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 difficult to assess in the wild and therefore is primarily documented at conservation hatcheries, fish culture facilities and commercial 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 direct genetic effects from farmed salmon escapees interbreeding with wild salmon still exist.

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 in-stream 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. Impacts to substrate and cover, water quality, water temperature, biological communities, and migratory corridors, among a host of other factors, have impacted the quality and quantity of habitat available to Atlantic salmon populations within the GOM DPS. Additionally, smallmouth bass and other non-indigenous species (such as brown trout introductions in the Merrymeeting Bay SHRU), significantly degrade habitat productivity throughout each of the SHRUs by altering natural predator/prey relationships.

Today, dams are the greatest impediment, outside of marine survival, to the recovery of salmon in the Penobscot, Kennebec and Androscoggin river basins (Fay *et al.* 2006). Hydropower dams in the Penobscot and Merrymeeting Bay SHRUs significantly impede the migration of Atlantic salmon and other diadromous fish and either reduce or eliminate access to roughly 330,000 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.

In the Downeast 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.

Efforts to Protect the GOM DPS and its Critical Habitat

Efforts aimed at protecting Atlantic salmon and their habitats in Maine have been underway for well over one hundred years. A wide variety of activities have focused on protecting Atlantic salmon and restoring stream connectivity within the GOM DPS, including (but not limited to) hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to Atlantic salmon and developing effective restoration strategies. These efforts are supported by a number of federal, state, and local government agencies, as well as many non-governmental conservation organizations.

In light of the 2009 GOM DPS listing and designation of critical habitat, the Services in collaboration with the state of Maine and the Penobscot Indian Nation developed a recovery framework that identifies how these resource agencies and the Tribe will work together to achieve recovery for Atlantic salmon. The Framework consists of seven action teams: Conservation Hatchery, Genetics, Freshwater, Connectivity, Marine and Estuarine, Stock Assessment, and Education and Outreach. Teams include scientists and managers from federal, tribal and state agencies with specific skills and expertise. They may also include outside experts who provide technical, scientific, or feasibility information. The guiding Framework document identifies three primary objectives to focus our efforts; 1) Abundance; 2) Distribution, and; 3) Ecosystem Function and Diversity. It also includes specific actions identified by each action team that can be undertaken to work towards recovering Atlantic salmon. Framework meetings which are open to the public are held regularly in order to also engage the general public in Atlantic salmon recovery efforts. A recovery plan was developed by the Services when Atlantic salmon were first listed under the ESA. However, with the expanded listing that occurred in 2009, this recovery plan lacked information on recovery efforts for Atlantic salmon in a significant geographic portion of the newly expanded range of the DPS which included additional threats which were either not present or very limited in the range of the original DPS (e.g., large, hydropower producing dams). Thus, the Services are currently working on a recovery plan that covers the full range and scope of threats to the listed DPS.

3.4.1 Summary of Information on Atlantic Salmon in the Action Area

Adult returns for the GOM DPS remain well below conservation spawning escapement (CSE) required to sustain themselves (Fay *et al.* 2006), which is further indication of their poor population status. As noted previously, the abundance of Atlantic salmon in the GOM DPS has been low and declining over the past several decades. Furthermore, the proportion of naturally-reared adult fish returning to natal rivers to spawn is very small (approximately 6% over the last ten years). 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 significantly contributed to an increase in the overall abundance of naturally reared adults returning to the rivers and stream within the GOM DPS. Accordingly, continued reliance on the conservation hatchery program could prevent extinction but will not allow recovery of the GOM DPS, which must be accomplished through increases in naturally reared salmon.

A number of anthropogenic activities within the GOM DPS will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other in-stream 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 GOM DPS.

4. ENVIRONMENTAL BASELINE OF THE ACTION AREA

The Environmental Baseline provides a discussion of a species health or status within the action area during the period of time the action is occurring and is used as a biological basis upon which to analyze the effects of the proposed action. Assessment of the environmental baseline includes an analysis of 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 action area for this consultation includes the combined action areas for a specified quantity of project sites for which an exact location within the geographic range of the GOM DPS is known, however, the amount of suitable Atlantic salmon habitat is not quantified (Table 1). Consequently, it is not possible to precisely define 1) the current condition of Atlantic salmon and its critical habitat within the individual project action areas, 2) the factors responsible for those conditions, or 3) the conservation role of those specific areas. Therefore, in order to complete the jeopardy and destruction or adverse modification of critical habitat analyses in this Opinion, we made several assumptions regarding the environmental baseline in each action area. These assumptions include the following: 1) overall abundance of Atlantic salmon is very low and is orders of magnitude lower than historic abundance levels; 2) the percentage of naturally reared fish versus those from hatchery supplementation efforts is low throughout the GOM DPS; 3) low marine survival is negatively affecting the entire GOM DPS and contributing to low numbers of adult returns to all rivers; 4) Atlantic salmon abundance in each project's action area will vary depending on the location relative to ongoing conservation hatchery stocking locations and known spawning activity; 5) throughout the GOM DPS access to and quality of salmon habitat is often affected by dams and poorly designed road-stream crossings, limiting the current function of migration, spawning and rearing habitats.

As described above in the Status of the Species section, the many factors that are influencing the current population of the GOM DPS and the condition of critical habitat are largely ubiquitous throughout the range of Atlantic salmon. Therefore, we believe that our analyses and conclusions in this Opinion are broadly applicable to the numerous projects that we will be considering under the proposed EPA Fish Assemblage survey. Finally, a more precise delineation of the action area for each site was considered as part of this Opinion.

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).

5.1. Background Information on Global climate change

The global mean temperature has risen 0.76°C (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 2007) 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 (IPCC 2007). 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 2007); 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 3-5°C (5-9°F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2°C (0.4° F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene *et al.* 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000 meters (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 Penobscot 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). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpounded 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°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 centimeters (6-8 inches).

5.2. Effects to 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 river catchments where salmon are found are heavily populated and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliot *et al.* 1998). Climate effects related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland1998). 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, and may increase predator risks, and/or thermal stress (Friedland 1998). Since the highest mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater *et al.* 2003). Temperature influences the length of egg incubation periods for salmonids (Elliot *et al.* 1998) and higher water temperatures could accelerate embryo development of salmon and may cause increased deformities and premature emergence of fry, which could result in decreased survival.

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 (Elliot *et al.* 1998). The changes in rainfall patterns expected from climate change and the impact of those rainfall patterns on flows in streams and rivers may severely impact productivity of salmon populations (Friedland 1998). More winter precipitation falling as rain instead of snow can lead to elevated winter peak flows which can scour the streambed and destroy salmon eggs (Battin *et al.* 2007, Elliot *et al.* 1998). Increased sea levels in combination with higher winter river flows could cause degradation of estuarine habitats through increased wave damage during storms (NSTC 2008). Since juvenile Atlantic salmon are known to select stream habitats with particular characteristics, changes in river flow may affect the availability and distribution of preferred habitats (Riley *et al.* 2009). Unfortunately, the critical point at which reductions in flow begin to have a damaging impact on juvenile salmonids is difficult to define, but generally flow levels that promote upstream migration of adults are likely adequate to encourage downstream movement of smolts (Hendry *et al.* 2003).

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

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

6. EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, 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). We have not identified any interrelated or interdependent actions.

6. 1 Effects of the Action on Atlantic salmon

The activities below are expected to affect the GOM DPS of Atlantic salmon as well as designated critical habitat. The sections that follow present our analysis of the effects of electrofishing activities associated with the EPA National Rivers and Streams Assessment.

6.1.1 Electrofishing Effects

Atlantic salmon may be killed or more likely temporarily disturbed, displaced, or injured by electrofishing activities. Capturing and handling salmon can cause physiological stress and lead to physical injury or death, including cardiac or respiratory failure from electrofishing (Snyder

2003). Studies have shown that all aspects of fish handling are stressful and can potentially lead to immediate or delayed mortality (Murphy and Willis 1996). Direct mortality may occur when fish are handled roughly, not properly restrained, sedated during handling, or kept out of the water for extended periods. Fish injured during handling, in association with a disease epizootic, typically die within one to fourteen days. Examples of injuries that can lead to disease problems are loss of mucus, loss of scales, damage to the integument, and internal damage. Therefore, despite precautions, we anticipate some mortality is possible during the sampling of fish. However, to minimize handling and avoid duplicative sampling of juvenile Atlantic salmon parr during the year, the EPA contractors have agreed to coordinate their efforts with the MDMR staff when sampling rivers and streams with Atlantic salmon in Maine.

The MDMR has a long term data set used for comparing juvenile densities across years and habitat types. These data provide valuable information that can be used to compare juvenile survival across SHRUs and various year classes to better understand the effects of electrofishing and handling. These annual population assessments are critical to evaluating the productivity of the available habitat for the species. These data are also useful when evaluating different management practices and stocking efforts used to recover this species. While there is concern sampling may affect the behavior of fish in the short term, there is no evidence to conclude there have been any long term effects to this species from electrofishing activities used for obtaining annual population estimates. The MDMR annually assesses populations of endangered GOMDPS Atlantic salmon and reports juvenile salmon mortality rates associated with electrofishing activities in GOM DPS waters as part of a Section 10 (a)(1)(A) permit authorized by the USFWS. To collect this data, the MDMR usually handles a few thousand juvenile salmon each year during electrofishing with mortalities typically less than two percent of total fish captured. To reduce mortalities further, MDMR staff instituted changes in operating protocols that lowered electrofishing mortality of YOY salmon from 2.72 percent in 2001 to 0.44 percent in 2011 (Trial 2012). Accordingly, total electrofishing mortality in 2011 for juvenile salmon was 0.69 percent. From 2007-2011, MDMR reported a mean mortality of 1.38 percent for both YOY and 1+ or older parr combined, with the number of salmon handled ranging between 3,480 and 9,419.

Baum (1997) reported that Maine Atlantic salmon rivers support, on average, between five and ten parr per 100 m^2 of habitat (or one salmon habitat unit), based on data collected by the MDMR. MDMR calculated juvenile salmon densities within areas deemed suitable for rearing in multiple rivers within all three SHRUs in the GOM DPS (USASAC 2012; Table 5). The five-year (2006-2011) GOM DPS average for juvenile Atlantic salmon median densities is 10.3 salmon/100 m^2. These data were obtained from electrofishing efforts in many streams and rivers located in watersheds throughout the GOM DPS and represent the best available scientific information to assist in determining the number of juvenile Atlantic salmon that are likely to be captured during electrofishing activities as a result of the EPA National Rivers and Streams Assessment.

Table 5. Median juvenile (salmon/100 m^2) Atlantic salmon densities sampled from within streams and rivers in the GOM DPS by MDMR between 2006 and 2011 (USASAC 2012).

	GOM DPS	Downeast Coastal	Merrymeeting Bay	Penobscot Bay

2006	2.5	5.7	1.6	0.2
2007	4.8	10.2	4.3	0.0
2008	13.7	10.6	3.8	26.6
2009	19.4	11.4	9.1	37.7
2010	12.0	13.2	5.2	17.8
2011	9.3	6.2	10.5	11.1
Average	**10.3**	**9.6**	**5.8**	**15.6**

Survey sites that have the potential to capture some juvenile Atlantic salmon are identified in Table 1. It is also likely that some electrofishing sites in Maine which are located within designated critical habitat do not contain juvenile salmon. This is primarily due to stream connectivity and/or hatchery stocking practices throughout the geographic range of the GOM DPS of Atlantic salmon as described in Section 4 above. As such, it is anticipated the majority, if not all, Atlantic salmon encountered would be hatchery origin individuals.

The number of juveniles likely to be harassed, injured, or killed can be quantified based on the estimated area affected and the SHRU-specific median densities (Table 5) that may occur at the designated site. It is difficult to know how much habitat will be sampled per electrofishing site, but the anticipated amount of Atlantic salmon habitat is based on the MDMR site selection process to define suitable sites for assessing fish populations within Maine. Accordingly, each site is expected to have different characteristics (i.e. depth and width of river and Atlantic salmon habitat present) that will define the upstream and downstream boundaries within the site. However, it can be conservatively estimated that no more than three habitat units of rearing habitat would be affected per site, based on the mean wetted stream width and a maximum length of 40 times the wetted width, which would contain approximately 3 units of Atlantic salmon habitat (100 m^2).

It is assumed that during the survey all juvenile salmon within the site would be subject to some level of short term stress during electrofishing and the capture and handling process. There is a short recovery period after fish are released to acclimate to their surroundings, after which fish resume normal activities and actively feed. The number of injuries or mortalities can be quantified based on SHRU-specific estimates of juvenile densities, as well as the estimated mortality that may occur during capture and relocation. Based on recent data collected from MDMR annual juvenile assessments, it is anticipated that no more than 1.38% of the fish that are captured will suffer injury or death (Trial 2012).

Given the recent 2014 adult returns to GOM DPS rivers, the likelihood of an adult being present at any given project site is extremely rare. To support ongoing recovery efforts, any adult salmon returning to the Penobscot River that are captured at the lower most dam (Milford) are being retained at the Craig Brook National Fish Hatchery for broodstock. In addition, adult salmon will only be able to access a small subset of the sites identified in Table 1 given existing barriers to passage throughout the GOM DPS. Based on the most recent passage information for 2014, there is an extremely low likelihood of encountering an adult salmon in the wild. Also, prior to beginning any in-stream activity associated with sampling, a cursory survey will be conducted along the stream banks to ensure there are no adult salmon within the immediate action area being surveyed. Thus, we do not believe that any take of adults is reasonably likely to occur.

Downeast Coastal SHRU

The median juvenile (YOY and parr) density in the Downeast Coastal SHRU between 2006 and 2011 ranged between 5.7 and 13.2 juveniles/unit (average of 9.8 juveniles/unit) based on sampling conducted by MDMR in several rivers (USASAC 2012). Assuming this average density, it is anticipated that approximately 30 juvenile Atlantic salmon (9.8 juveniles/unit x 3 units) could be affected at each site considered in this opinion. Therefore, it is expected that up to 3 habitat units (1 site x 3 habitat units), as well as 30 juvenile salmon (3 habitat units x 9.8 juveniles/unit), could be affected by electrofishing activities over the term of the survey (July – September 2014).

Given a 1.38% mortality rate, it is expected that few juvenile salmon will be killed at any individual site. However, assuming that one site is sampled within the SHRU as proposed (Table 1), it is possible that one juvenile salmon (1.38% x 30 fish) may be injured or killed over the term of the survey as a result of electrofishing related to sampling efforts for the fish assemblage survey.

Merrymeeting Bay SHRU

The median juvenile (YOY and parr) density in the Merrymeeting Bay SHRU between 2006 and 2011 ranged between 1.6 and 10.5 juveniles/unit (average of 5.8 juveniles/unit) based on sampling conducted by MDMR in several rivers (USASAC 2012). Assuming this average density, it is anticipated that 17 juvenile Atlantic salmon (5.8 juveniles/unit x 3 habitat units affected per site) could be affected at each site considered in this Opinion. Therefore, it is expected that up to 3 habitat units (1 site x 3 habitat units), as well as 17 juvenile salmon (3 habitat units x 5.8 juveniles/unit), could be affected by electrofishing activities over the term of the survey (July – September 2014).

Given a 1.38% mortality rate, it is expected that few juvenile salmon will be killed at any given project. However, assuming that seven projects are sampled within the SHRU as proposed (Table 1), it is possible that one juvenile salmon (1.38% x 17 fish) may be injured or killed over the term of the survey as a result of electrofishing related to sampling efforts for the fish assemblage survey.

Penobscot Bay SHRU

The median juvenile (YOY and parr) density in the Penobscot Bay SHRU between 2006 and 2011 ranged between 0.0 and 37.7 juveniles/unit (average of 15.6 juveniles/unit) based on sampling conducted by MDMR in several rivers (USASAC 2012). Assuming this average density, it is anticipated that 47 juvenile Atlantic salmon (15.6 juveniles/unit x 3 units) could be affected at each site considered in this Opinion. Therefore, it is expected that up to 30 habitat units (10 projects x 3 habitat units), as well as 468 juvenile salmon (30 habitat units x 15.6 juveniles/unit), could be affected by electrofishing activities over the term of the survey (July – September 2014).

Given a 1.38% mortality rate, it is expected that few juvenile salmon will be killed at any given project. However, assuming that 10 sites are sampled within the SHRU as proposed (Table 1), it is possible that 6 (1.38% x 468 fish) juvenile salmon may be injured or killed over the term of the survey as a result of electrofishing related to sampling efforts for the fish assemblage survey.

6.1.2 Water Quality Effects

Sediments and Turbidity

Electrofishing activities associated with the proposed survey will temporarily introduce sediment and increase turbidity downstream of the site as some release of fine materials and turbidity is likely to occur as a result of these in-water activities. These activities will only occur on a small segment of river or stream at one time and will be of short duration (less than 2 hours), after which the substrate will return to similar conditions existing before the survey. We do not anticipate any additional long term effects to the substrate or water quality from the survey.

Elevated TSS concentrations have the potential to adversely affect Atlantic salmon in the action area. According to Herbert and Merkens (1961), the most commonly observed effects of exposure to elevated TSS concentrations on salmonids include: 1) avoidance of turbid waters in homing adult anadromous salmonids, 2) avoidance or alarm reactions by juvenile salmonids, 3) displacement of juvenile salmonids, 4) reduced feeding and growth, 5) physiological stress and respiratory impairment, 6) damage to gills, 7) reduced tolerance to disease and toxicants, 8) reduced survival, and 9) direct mortality. Fine sediment deposited in salmonid spawning gravel can also reduce interstitial water flow, leading to depressed DO concentrations, and can physically trap emerging fry on the gravel.

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580 mg/L to 700,000 mg/L depending on species. However, sublethal effects have been observed at substantially lower turbidity levels. Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments (DeVore *et al.* 1980, Birtwell *et al.* 1984, Scannell 1988). Salmonids have been observed to move laterally and downstream to avoid turbid plumes (McLeay *et al.* 1984, 1987, Sigler *et al.* 1984, Lloyd 1987, Scannell 1988, Servizi and Martens 1991). Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities, except when the fish need to traverse these streams along migration routes (Lloyd *et al.* 1987).

Exposure duration is a critical determinant of the occurrence and magnitude of physical or behavioral effects (Newcombe and MacDonald 1991). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991). However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Redding *et al.* 1987, Lloyd 1987, Servizi and Martens 1991). In a review of the effects of sediment loads and turbidity on fish, Newcombe and Jensen (1996) concluded that more than six days exposure to total suspended solids (TSS) greater than ten milligrams per liter is a moderate stress for juvenile and adult salmonids and that a single day exposure to TSS in excess of 50 mg/l is a moderate stress.

At moderate levels, turbidity has the potential to adversely affect primary and secondary productivity, and at high levels has the potential to injure and kill adult and juvenile fish. Turbidity might also interfere with feeding (Spence *et al.* 1996). Eggs and newly emerged salmonid fry may be vulnerable to even moderate amounts of turbidity (Bjornn and Reiser 1991). Other behavioral effects on fish, such as gill flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985). Fine redeposited sediments also have the potential to adversely affect primary and secondary productivity (Spence *et al.* 1996), and to reduce incubation success (Bell 1991) and cover for juvenile salmonids (Bjornn and Reiser 1991). Larger juvenile and adult salmon appear to be little affected by ephemeral high concentrations of suspended sediments that occur during most storms and episodes of snowmelt. However, other research demonstrates that feeding and territorial behavior can be disrupted by short-term exposure to turbid water.

In-water work will primarily be conducted by several individuals wading in the stream over a limited reach for a short time; therefore, sediment releases are only anticipated during the electrofishing activities from a minor disturbance of the substrate. Single day TSS levels in excess of 50 mg/l are not anticipated during these activities. Therefore, we do not expect any Atlantic salmon to be injured or killed due to exposure to elevated TSS or sediments during electrofishing activities.

6.2 Effects of the Action on Atlantic salmon Critical Habitat

As discussed in section 3.1.3, critical habitat for Atlantic salmon has been designated in the GOM DPS of Atlantic salmon. It is anticipated that many of the proposed sites (Table 1) would occur within the designated habitat. Within the action area of this consultation, the PCEs for Atlantic salmon that may be affected by the action are those associated with sites for spawning and rearing and sites for migration. The analysis presented in the status of the species and the environmental baseline shows several habitat indicators are not properly functioning, and biological requirements of Atlantic salmon are not being met in the action area. We have analyzed the potential impacts of the project on designated critical habitat and the PCEs in the action area. We have determined that the effects to these PCEs will be insignificant for the reasons outlined below.

In-stream activities associated with the electrofishing operation will only affect a small portion of the river at any given time. Some of the work will be done from an electrofishing boat and therefore, will not result in any effects to the receiving environment other than a temporary electrification of the immediate area in front of the boat (4.5 m diameter X 2.5 m depth) within the water column. When conducting the survey from a boat, personnel will not disturb the substrate or directly affect any essential physical and biological features of habitat used for spawning and rearing present within the site. Further, since there will only be a small area being electrified directly in front of the boat which could deter fish from passing through the affected area, this electric field will only be temporary (<1 minute) and would cover 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 juvenile Atlantic salmon moving past the area being sampled and would not act as a migration barrier. In smaller tributaries and wadeable streams, the substrate within the site being surveyed will be temporarily disturbed during operations; after the survey is completed the substrate will be fully restored to existing conditions. Any effects to the water column will be limited to temporary turbidity and electrification; there will be no other water quality impacts of the proposed action. Further, the project will not alter the habitat in any way that would increase the risk of predation. The types of species that will be stunned by the electrofishing gear and would 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 existing habitat, change the temperature, dissolved oxygen or alter the flow of water, there will be no reduction in the capacity of substrate, food resources, and natural cover to meet the conservation needs of listed Atlantic 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 is reasonably certain to occur are continuation of recreational fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

In December 1999, the State of Maine adopted regulations prohibiting all angling for sea-run salmon statewide. A limited catch-and-release fall fishery (September 15 to October 15) for Atlantic salmon was authorized in the Penobscot River by the MASC for 2007. The fishery was closed prior to the 2009 season. Despite strict state and federal regulations, both juvenile and adult Atlantic salmon remain vulnerable to injury and mortality due to incidental capture by recreational anglers and incidental catch in commercial fisheries. The best available information indicates that Atlantic salmon are still incidentally caught by recreational anglers. Evidence suggests that Atlantic salmon are also targeted by poachers (NMFS 2005). Commercial fisheries for elvers (juvenile eels) and alewives may also capture Atlantic salmon as bycatch. No estimate of the numbers of Atlantic salmon 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). 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.

Impacts to Atlantic salmon from all of these activities are largely unknown. However, we have no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

8 INTEGRATION AND SYNTHESIS OF EFFECTS

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the GOM DPS of Atlantic salmon. 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. In addition, the analysis will determine whether the proposed action will destroy or 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." Jeopardize the continued existence of is defined in the regulations (50 CFR 402.02) as "an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act." Therefore, to determine if the proposed action will jeopardize the GOM DPS of Atlantic salmon, an analysis of the effects on survival and recovery must be conducted.

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

8.1 Atlantic Salmon

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

Summary of electrofishing effects

Since the precise locations of the projects that will be surveyed are known, we generally know whether Atlantic salmon will be present in the action area of each project, however, we would not know the density at which they may occur. Therefore, certain assumptions may be made based on the known distribution of salmon in the GOM DPS, as well as on the State of Maine's stocking strategy. Given current stocking strategies, it is assumed that juvenile salmon of hatchery origin could be present in most streams within the GOM DPS. Therefore, it is possible that stocked juvenile salmon could be present in the action area for each site identified in Table 1. Capturing and handling juvenile salmon causes physiological stress and can cause physical injury or mortality. However, these effects can be kept to a minimum through proper handling procedures as specified in the State of Maine Department of Marine Resources Electrofishing in Wadeable Streams in Maine protocols (Attachment 1). As a recommendation to minimize handling of GOM DPS Atlantic salmon, qualified biologists from the MDMR may assist with electrofishing activities to enable data sharing and reduce duplicative sampling.

Only a very small subset of rivers could potentially have adult salmon in the action area as free-swimming adults, but these areas are limited to the habitat downstream of the lower most impassable barrier on each tributary. At most electrofishing sites proposed, there are currently upstream passage barriers and are not accessible to migrating adult salmon. As such, it is not expected that any adult Atlantic salmon would be migrating through the action area and therefore all direct effects to adults from electrofishing will be insignificant and discountable.

Conducting in-stream activities associated with electrofishing could cause localized turbidity and disturbance of substrates. These impacts are anticipated to occur on the smaller wadeable streams and be limited to a small footprint and short-term, and will be minimized by conducting in-stream activities during summer months when stream flow is low. Since the action will not affect the natural structure of the existing habitat, change the temperature, dissolved oxygen or alter the flow of water, there will be no reduction in the capacity of substrate, food resources, and natural cover to meet the conservation needs of listed Atlantic salmon. It is anticipated the substrate within the site will return to pre-survey conditions after electrofishing activities are complete. Therefore, the proposed action is expected to have a very minor, extremely short-term negative impact on water quality in the GOM DPS.

8.1.1 Survival and Recovery Analysis

In this section, we analyze the effects of the proposed action on the GOM DPS of Atlantic salmon in conjunction with the environmental baseline and the status of the species.

Survival analysis

While conducting electrofishing activities within the GOM DPS are expected to result in injury and mortality of some Atlantic salmon, no adults and very few (if any), juvenile salmon would be injured or killed. Juvenile abundance surveys are routinely conducted annually to assess the productivity of available habitat and have provided valuable data to assist in the recovery of the species. This technique is well established in the fisheries field and these assessment activities have provided a long term data set with a large geographic coverage throughout Maine. Based on MDMR juvenile density data (2006-2011) and an estimate of the number of sites expected to be surveyed in each SHRU, it is anticipated that up to 528 juvenile salmon (30, 30, 468 in the Downeast Coastal, Merrymeeting Bay, and Penobscot Bay SHRUs, respectively) could be captured and harassed over the term of the survey. The majority of these fish will be returned safely to the stream after the activities are completed. Of the 528 juvenile salmon handled, it is expected that a total of 8 (1, 1, and 6 in the Downeast Coastal, Merrymeeting Bay, and Penobscot Bay SHRUs, respectively) could potentially be killed over the survey period. Since the majority of sites proposed are currently being stocked as part of efforts to recover the species, it is reasonable to assume any fish encountered are of hatchery origin and are an extremely small percentage of fish stocked annually (>1 million). While there is concern sampling may affect the behavior of fish in the short term, there is no evidence to conclude there have been any long term effects to this species from electrofishing activities used for obtaining annual population estimates. Furthermore, the limited spatial coverage (36 units of habitat) and short term duration of the study (6 months) will greatly reduce the potential of the electrofishing activities to adversely affect a large portion of the population and the long-term survival potential of the species. There would also be no measurable reduction in returning adults and reproductive success or juvenile distribution within the SHRU. Therefore, Based on the information provided above, we have determined that the proposed action will have a localized and short term adverse effect on Atlantic salmon in the GOM DPS but not appreciably reduce the likelihood that Atlantic salmon will survive in the wild.

Recovery Analysis

The second step in conducting this analysis is to assess the effects of the proposed project on the recovery of the species. Recovery is defined as 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 (USFWS and NMFS 1998). As with the survival analysis, there are three criteria that are evaluated under the recovery analysis: reproduction, numbers and distribution. The recovery scenario incorporates baseline conditions, but does not include hatchery supplementation as it is assumed that in a recovered population, stocking will not be necessary to sustain a viable population. In certain instances 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. Although the population growth rate of Atlantic salmon will still have a downward trend after the completion of the proposed project, an increase in available habitat through improved upstream and downstream passage would lead to an improvement in the baseline condition of the species, and will make recovery more likely should other parameters, such as marine and freshwater survival, improve in the future.

At existing freshwater and marine survival rates (the medians have been estimated by NMFS as 1.1% and 0.4%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. A significant increase in either one of these parameters (or a lesser increase in both) will be necessary to overcome the significant obstacles to recovery. We have created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (NMFS 2010). In Figure 3, 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 horizontal 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, path to achieving a self-sustaining population that is trending towards recovery.

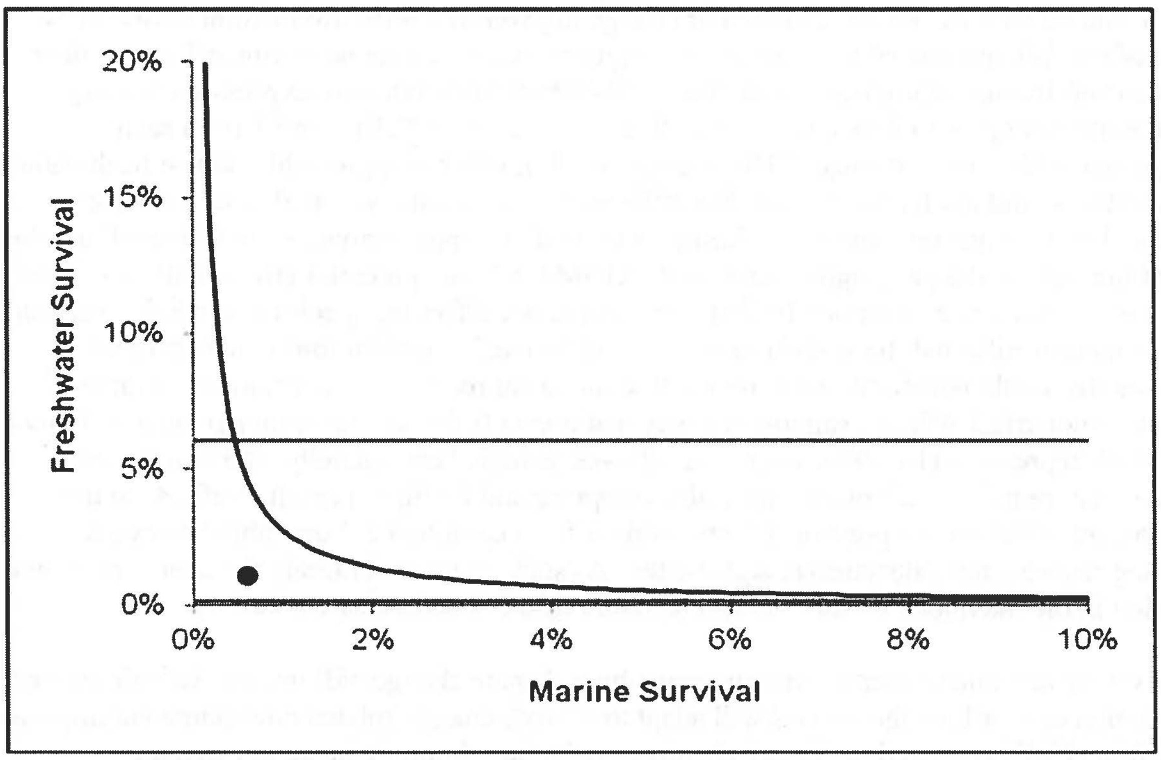

Figure 3. NMFS (2010) conceptual model depicting marine and freshwater survival relative to recovery of the GOM DPS of Atlantic salmon (Note: The dot represents current conditions, the curved line represents recovery, and the horizontal lines are the historic maximum and minimum freshwater survival).

In the mid-1980's to early 1990's there was a 50 to 70% decline in Atlantic salmon marine survival rates. This event is referred to as the regime shift (Chaput *et al.* 2005), the causes of which are unknown at this time (Windsor *et al.* 2012). Based on the smolt to adult return rate for wild fish in the Narraguagus River, USFWS (2012b) estimated that the pre-regime shift marine survival rate ranged between 0.9% and 5.2%, with an average of 3.0%. Since marine survival rates are an estimate based on returning adults over a larger geographic scale, we anticipate no measurable difference in the marine survival rates as a result of conducting this survey.

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. Fortunately, there has been a change in this trend and is supported by data collected from recent juvenile assessments which have shown an increase in large parr abundance across all SHRUs in response to hatchery stocking efforts (USASAC 2013).

The species is currently at a state where recovery will be extremely difficult due to poor marine and freshwater survival rates, however, we do not believe this study would appreciably reduce the species' likelihood for recovery for the following reasons. First, there would be no measurable reduction in the number of returning adults and their reproductive success. Second, there would be no measurable reduction or change in juvenile distribution within each SHRU. Third, of the fish anticipated to be harassed or injured, we anticipate no lasting effects on their ability to survive and reproduce. Since the freshwater survival rates are expressed on a larger spatial scale, losing up to 8 fish, (i.e., 6 fish from the Penobscot SHRU and 1 from each Merrymeeting Bay and Downeast SHRUs respectively), will not appreciably reduce freshwater survival and would not have a measurable difference in freshwater survival rates for these SHRUs. Lastly, since this survey has limited temporal and spatial coverage with a small number of sites throughout the geographic range of the GOM DPS, any potential effects will be limited to the period July 1 to September 30, 2014 and would not affect the species as a whole. Further, the information collected through these studies will be used to inform future management decisions that could potentially increase the likelihood for recovery. Therefore, the proposed action will not affect Atlantic salmon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent Atlantic salmon from completing their entire life cycle, including reproduction, sustenance, and shelter. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery of the species as a whole.

While we are not able to predict with precision how climate change will impact Atlantic salmon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to Atlantic salmon in the action area are anticipated over the term of this study. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change.

8.2 Atlantic Salmon Critical Habitat

Critical habitat for Atlantic salmon has been designated in the GOM DPS. As noted previously, within the action area of this consultation, the PCEs for Atlantic salmon include: 1) sites for spawning and rearing; and, 2) sites for migration (excluding marine migration).

The electrofishing activities analyzed in this opinion will temporarily reduce the functioning of critical habitat in the immediate vicinity of the site. It is estimated that an average of three habitat units per site will be temporarily impacted by the in-water work during electrofishing activities. This is a very temporary short term impact to critical habitat and will temporarily degrade the functioning of the rearing and spawning PCE due to elevated turbidity levels.

The migration PCE is not currently fully functional at any site above a barrier due to the lack of effective upstream fish passage. The temporary disturbance that will occur as a result of the electrofishing activities is not expected to further degrade the PCE. Therefore, electrofishing activities are unlikely to affect the functioning of the habitat for upstream or downstream migration of juvenile Atlantic salmon.

Overall, designated critical habitat in the GOM DPS is anticipated to essentially remain unchanged with the implementation of the proposed survey. Since the action will not affect the natural structure of the existing habitat, change the temperature, dissolved oxygen or alter the flow of water, there will be no reduction in the capacity of substrate, food resources, and natural cover to meet the conservation needs of listed Atlantic salmon. It is anticipated the substrate within the site will return to pre-survey conditions after electrofishing activities are complete. Therefore, the proposed action is expected to have a very minor, extremely short-term negative impact on water quality in the GOM DPS. Therefore, the proposed project is not likely to adversely modify or destroy Atlantic salmon critical habitat.

9 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under our jurisdiction, the environmental baseline for 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 the GOM DPS of Atlantic salmon. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of critical habitat designated for the GOM DPS. We have also concluded that the proposed action is not likely to adversely affect shortnose sturgeon, the NYB, GOM, Chesapeake Bay, South Atlantic or Carolina DPSs of Atlantic sturgeon.

10 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, non-migratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof." 16 U.S.C. 1532(8). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person "to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]" 16 U.S.C. 1538(g). A "person" is defined in part as any entity subject to the jurisdiction of the United States, including an individual, corporation, officer, employee, department or instrument of the Federal government (see 16 U.S.C. 1532(13)). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of carrying out an otherwise lawful activity is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement. In issuing this ITS, NMFS takes no position on whether the action is an "otherwise lawful activity."

10.1 Amount or Extent of Take

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

As explained in the "Effects of the Action" section, while shortnose and Atlantic sturgeon may occur in the action area, we do not anticipate any incidental take of these species. No other species listed by NMFS occur in the action area; thus incidental take of other species is not anticipated.

Atlantic salmon

Due to the short-term nature of the in-stream work and the timing of the work window in relation to the adult run-timing, it is anticipated that a small proportion of the total annual run could be migrating upstream in the GOM DPS at the time that electrofishing activities are underway. However, given the recent 2014 adult returns to GOM DPS rivers, as well as a lack of upstream access at many dams, the likelihood of an adult being present at any given site is extremely small. For example, only 258 salmon have passed the lower most dam (Milford) on the Penobscot River and all of these fish, with the exception of a few released for tracking, have been taken back to the hatchery for broodstock. Furthermore, given the level of in-stream activity associated with setting up the site and other electrofishing-related activities along the stream banks, any adult salmon that may be present in the project areas would very likely move away from the survey area. Therefore, we do not believe that take of an adult salmon is reasonably likely to occur.

Capture and relocation of juveniles during electrofishing activities will potentially result in harassment, injury, and mortality of Atlantic salmon juveniles. The number of juveniles likely to be harassed, injured, or killed was quantified based on estimated area affected and median densities that may occur during capture. The amount of habitat sampled within a site will depend on the site characteristics of the stream, but has been conservatively estimated at up to three habitat units.

All juvenile salmon within the selected site will be subject to harassment or harm during the capture and handling process, these fish would be returned to the river alive and would not have any lasting effects that could reduce their ability to survive. There may also be a small subset of fish that could be killed as a result of electrofishing, capture, and handling (Table 7). The number of juvenile salmon anticipated to be harassed, injured, or killed was quantified based on SHRU-specific estimates of parr and YOY densities, as well as the estimated mortality that may occur during capture and handling. We expect that no more than 1.38% of the fish that are captured will suffer injury or death (Trial 2012). It is anticipated no adult Atlantic salmon will be encountered, captured and handled and therefore, no take of adult Atlantic salmon is anticipated.

Table 7. Estimate of take of juvenile Atlantic salmon anticipated due to the electrofishing activities conducted by EPA during their Fish Assemblage surveys.

SHRU	Harassment	Mortality
Downeast Coastal	30	1
Merrymeeting Bay	30	1
Penobscot Bay	468	6
GOM DPS	528	8

10.2 Reasonable and Prudent Measures

To minimize handling stress and mortality to captured Atlantic salmon parr, EPA must adhere to the following reasonable and prudent measures, including following water temperature thresholds for field sampling. In order to effectively monitor the effects of this action, it is necessary to monitor and document the amount of incidental take (i.e., the number of each species captured, collected, injured or killed). Monitoring provides information on the number of individuals encountered and may provide data which will help understand species distribution and avoid future interactions with listed species. NMFS believes the following reasonable and prudent measures are necessary or appropriate for EPA and their contractors to minimize and monitor impacts of incidental take of listed species.

1. EPA must coordinate all electrofishing activities in the State of Maine with Maine DMR.
2. EPA must implement protocols to minimize the potential for mortality of Atlantic salmon.
3. EPA must report all interactions with listed species to NMFS in a timely manner.

10.3 Terms and Conditions

1) To implement RPM #1, to minimize handling and duplicative sampling of wild Atlantic salmon parr, EPA must coordinate electrofishing activities with Maine DMR in Rivers and Streams containing Atlantic salmon (Table 1) whenever possible. Contact person at Maine DMR is Oliver Cox who can be reached via email (Oliver.N.Cox@maine.gov) or phone 207-941-4487.
2) To implement RPM #2, to minimize handling stress and mortality to captured Atlantic salmon parr, EPA must adhere to the Maine DMR Electrofishing Protocols (see Appendix A), including following water temperature thresholds for field sampling.
3) To implement RPM #3, EPA must notify NMFS within 24 hours of any interactions with listed species by phone (David Bean, 207-866-4172). A written report must be submitted via e-mail (incidental.take@noaa.gov) on the next business day. The report must include information on the location of the incident, the condition of the fish and photographs (whenever possible).
4) To implement RPM#3, EPA must submit an annual report to the NMFS GARFO office describing electrofishing activities conducted and listing any interactions with listed species.

11 CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered 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. As such, NMFS recommends that the EPA consider the following Conservation Recommendation:

1. EPA should use its authorities to support studies on the effects of water quality and electrofishing on NMFS listed species and their habitats.

12 REINITIATION NOTICE

This concludes formal consultation concerning your proposal to survey designated rivers and streams in Maine that could contain endangered Atlantic salmon. 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. If there is any incidental take of shortnose or Atlantic sturgeon, or adult sea-run Atlantic salmon reinitiation would be required.

13 LITERATURE CITED

Alden Research Laboratory, Inc. 2012. Atlantic Salmon Survival Estimates At Mainstem Hydroelectric Projects on the Penobscot River. Prepared by S. Amaral, C. Fay, G. Hecker and N. Perkins. 556 pps.

Allen, K.R. 1940. Studies on the biology of the early stages of the salmon (*Salmo salar*): growth in the river Eden. J. Animal Ecol. 9(1):1-23.

Arkoosh, M.R., E. Casillas, E. Clemons, A.N. Kagley, R. Olson, P. Reno, and J.E. Stein. 1998a. Effect of pollution on fish diseases: potential impacts on salmonid populations. Journal of Aquatic Animal Health 10:182-190.

Arkoosh, M.R., E. Casillas, P. Huffman, E. Clemons, J. Evered, J.E. Stein, and U. Varanasi. 1998b. Increased susceptibility of juvenile Chinook salmon from a contaminated estuary to *Vibrio anguillarum*. Transactions of the American Fisheries Society 127: 360-374.

ASA (Analysis and Communication). 2008. 2006 year class report for the Hudson River Estuary Program prepared for Dynegy Roseton LLC, on behalf of Dynegy Roseton LLC Entergy Nuclear Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, and Mirant Bowline LLC. Washingtonville NY.

Bakshtansky, E.L.,V.D. Nesterov and M.N. Nekludov. 1982. Change in the behaviour of Atlantic salmon (*Salmo salar*) smolts in the process of downstream migration. ICES, 16 pages.

Bain, Mark B., N. Haley, D. L. Peterson, K. K. Arend, K. E. Mills, P. J. Sullivan. 2000. Annual meeting of American fisheries Society. EPRI-AFS Symposium: Biology, Management and Protection of Sturgeon. St. Louis, MO. 23-24 August 2000.

Barr, L.M. 1962. A life history of the chain pickerel, *Esox niger Lesueur*, in Beddington Lake, Maine. M.S. Thesis University of Maine, Orono, ME: 88 pp.

Bates, B.C., Z.W. Kundzewicz, S. Wu, and J.P. Palutikof (Eds.). 2008. Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change (IPCC), IPCC Secretariat, Geneva 1-210.

Battin, J., M. Wiley, M. Ruckelshaus, R. Palmer, E. Korb, K. Bartz, and H. Imaki. 2007. Project impacts of climate change on habitat restoration. Proceedings of the National Academy of Sciences 104, no. 16: 6720-6725.

Baum, E.T. 1997. Maine Atlantic salmon - a national treasure. Atlantic Salmon Unlimited, Hermon, Maine.

Baum, E.T. and A.L. Meister. 1971. Fecundity of Atlantic salmon (*Salmo salar*) from two Maine rivers. J. Fish. Res. Bd. Can. 28(5):7640767.

Beland, K.F., R.M. Jordan and A.L. Meister. 1982. Water depth and velocity preferences of spawning Atlantic salmon in Maine Rivers. North American Journal of Fisheries Management 2:11-13.

Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. U.S. Army Corps of Engineers. North Pacific Division.

Berg, L. and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (Oncorhynuchus kisutch) following short-term pulses of suspended sediment. Can. J. Aquat. Sci. 42(8): 1410-1417.

Beaugrand, G. and P. Reid. 2003. Long-term changes in phytoplankton, zooplankton, and salmon related to climate. Global Change Biology 9: 801-817.

Birtwell, I.K, G. Hartman, B. Anderson, D.J. McLeay and J.G. Malik. 1984. A brief investigation of Arctic grayling (Thymallus arcticus) and aquatic invertebrates in the Minto Creek drainage, Mayo, Yukon Territory Can. Tech. Rept. Fish. Aquat. Sci. 1287.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in Meehan, W.R (ed.). 1991. Influences of forest and rangeland management of salmonid fishes and their habitats. Am. Fish. Soc. Special Publication 19. Bethesda, MD.

Blackwell, B.F., W.B. Krohn, N.R. Dube, and A.J. Godin. 1997. Spring prey use by doublecrested cormorants on the Penobscot River, Maine, USA. Colonial Waterbirds 20(1): 77-

Blackwell, B.F. and F. Juanes. 1998. Predation on Atlantic salmon smolts by striped bass after dam passage. North American Journal of Fisheries Management 18: 936-939.

Bley, P.W. 1987. Age, growth, and mortality of juvenile Atlantic salmon in streams: a review. Biological Report 87(4). U.S. Fish and Wildlife Service, Washington, D.C.

Bley, P.W. and J.R. Moring. 1988. Freshwater and ocean survival of Atlantic salmon and steelhead: a synopsis. Biological Report 88(9). Maine Cooperative Fish and Wildlife Research Unit, Orono.

Breau, C., L. Weir and J. Grant. 2007. Individual variability in activity patterns of juvenile Atlantic salmon (Salmo salar) in Catamaran Brook, New Brunswick. Canadian Journal of Fisheries and Aquatic Science 64: 486-494.

Buckley, J. and B. Kynard. 1985. Habitat use and behavior of pre-spawing and spawning shortnose sturgeon, *Acipenser brevirostrum*, in the Connecticut River. North American Sturgeons: 111-117.

Budy, P., G. P. Thiede, N. Bouwes, C.E. Petrosky, and H. Schaller. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22: 35-51.

Burton, W. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Prepared by Versar, Inc. for the Delaware Basin Fish and Wildlife Management Cooperative, unpublished report. 30 pp.

Chaput, G., Legault, C.M., Reddin, D.G., Caron, F., and Amiro, P.G. 2005. Provision of catch advice taking account of non-stationarity in productivity of Atlantic salmon (Salmo salar L.) in the Northwest Atlantic. ICES Journal of Marine Science, 62: 131-143.

Clews, E., I. Durance, I.P. Vaughan and S.J. Ormerod. Juvenile salmonid populations in a temperate river system track synoptic trends in climate. Global Change Biology 16 (2010): 3271-3283.

Collins, M., K. Lucey, B. Lambert, J. Kachmar, J. Turek, E. Hutchins, T. Purinton, D. Neils. 2007. Stream barrier removal monitoring guide. [Internet]. Gulf of Maine Council on the Marine Environment. [cited 9 February 2011]. Available from: www.gulfofmain.org/streambarrierremoval.

Cunjak, R.A. 1988. Behavior and microhabitat of young Atlantic salmon (*Salmo salar*) during winter. Can. J. Fish. Aquat. Sci. 45(12): 2156-2160.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* Lesueur 1818. NOAA Technical Report, NMFS 14, National Marine Fisheries Service. October 1984 45 pp.

Danie, D.S., J.G. Trial, and J.G. Stanley. 1984. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (North Atlantic) – Atlantic salmon. U.S. Fish Wildl. Serv. FW/OBS-82/11.22. U.S. Army Corps of Engineers, TR EL-82-4. 19 pp.

Dempson, J.B., M.F. O'Connell, and M. Shears. 1996. Relative production of Atlantic salmon from fluvial and lacustrine habitats estimated from analyses of scale characteristics. J. Fish Biol. 48: 329-341

deGaudemar B., Beall E. 1998. Effects of overripening on spawning behaviour and reproductive success of Atlantic salmon females spawning in a controlled flow channel. J Fish Biol 53:434-446.

DeVore, P.W., L.T. Brooke, and W.A. Swenson. 1980. The effects of red clay turbidity and sedimentation on aquatic life in the Nemadji River System. Impact of nonpoint pollution control on western Lake Superior. EPA Report 905/9-79-002-B. U.S. Environmental Protection Agency, Washington, D.C.

Dolat, S.W. 1997. Acoustic measurements during the Baldwin Bridge Demolition. Sonalysts, Inc. Waterford, CT.

Dovel, W.L., A.W. Pekovitch, and T.J. Berggren. 1992. Biology of the shortnose sturgeon (*Acipenser brevirostrum* Lesueur 1818) in the Hudson River estuary, New York. Pages 187-216 in C.L. Smith (editor). Estuarine research in the 1980s. State University of New York Press, Albany, New York.

Drinkwater, K., A. Belgrano, A. Borja, A. Conversi, M. Edwards, C. Greene, G. Ottersen, A. Pershing and H. Walker. 2003. The Response of Marine Ecosystems to Climate Variability Associated with the North Atlantic Oscillation. Geophysical Monograph 134: 211-234.

Dube, N.R. 1988. Penobscot River 1987 radio telemetry investigations. Maine Atlantic Sea-Run Salmon Commission. Bangor, ME. 22 pp. and appendices.

Dutil, J.D. and J.M. Coutu. 1988. Early marine life of Atlantic salmon, *Salmo salar*, postsmolts in the northern Gulf of St. Lawrence. Fish. Bull. 86(2):197-211.

Elliott, J.M. 1991. Tolerance and resistance to thermal stress in juvenile Atlantic salmon, *Salmo salar*. Fresh. Biol. 25:61-70.

Elliot, S., T. Coe, J. Helfield and R. Naiman. 1998. Spatial variation in environmental characteristics of Atlantic salmon (Salmo salar) rivers. Canadian Journal of Fisheries and Aquatic Sciences 55, suppl. 1: 267-280.

Erkinaro, J., Y. Shustov, and E. Niemelä. 1995. Enhanced growth and feeding rate in Atlantic salmon parr occupying a lacustrine habitat in the river Utsjoki, northern Scandinavia. J. Fish Bio. 47(6): 1096-1098.

Erkinaro, J., E. Niemelä, A. Saari, Y. Shustov, and L. Jøgensen. 1998. Timing of habitat shift by Atlantic salmon parr from fluvial to lacustrine habitat: analysis of age distribution, growth, and scale characteristics. Can. J. Fish. Aquat. Sci. 55: 2266-2273.

Fay, C., M. Bartron, S. Craig, A. Hecht, J. Pruden, R. Saunders, T. Sheehan, and J. Trial. 2006. Status review for anadromous Atlantic salmon (*Salmo salar*) in the United States. Report to the National Marine Fisheries Service and U.S. Fish and Wildlife Service. 294 pages.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Agreement in principle for interim criteria for injury to fish from pile driving activities. Memorandum signed June 12, 2008.

Food and Agriculture Organization of the United Nations (FAO). 2012. Species Fact Sheets, Salmo salar. FAO Fisheries and Aquaculture Department. http://www.fao.org/fishery/species/2929/en (Accessed June 18, 2012).

Foster, N.W. and C.G. Atkins. 1869. Second report of the Commissioners of Fisheries of the state of Maine 1868. Owen and Nash, Printers to the State, Augusta, ME.

Friedland, K.D., D.G. Redding, and J.F. Kocik. 1993. Marine survival of N. American and European Atlantic salmon: effects of growth and environment. ICES J. of Marine Sci. 50: 481-492.

Friedland, K. 1998. Ocean climate influences on critical Atlantic salmon (Salmo salar) life history events. Canadian Journal of Fisheries and Aquatic Sciences 55, suppl. 1: 119-130.

Friedland, K.D., J.-D. Dutil, and T. Sadusky. 1999. Growth patterns in postsmolts and the nature of the marine juvenile nursery for Atlantic salmon, *Salmo salar*. Fish. Bull. 97: 472-481.

Friedland, K.D., D.G. Reddin, and M. Castonguay. 2003. Ocean thermal conditions in the post-smolt nursery of North American Atlantic salmon. ICES Journal of Marine Scienc. 60: 343-355.

Gibson, R.J. 1993. The Atlantic salmon in freshwater: spawning, rearing, and production. Reviews in Fish Biology and Fisheries. 3(1):39-73.

Gorsky, D. 2005. Site fidelity and the influence of environmental variables on migratory movements of adult Atlantic salmon (Salmo salar) in the Penobscot River basin, Maine. Master's thesis. University of Maine, Orono.

Greene CH, Pershing AJ, Cronin TM and Ceci N. 2008. Arctic climate change and its impacts on the ecology of the North Atlantic. Ecology 89:S24-S38

Gulf of Maine Council on the Marine Environment (GMCME). 2010. Gulf of Maine. 2005-2010. [Internet]. [Cited 7 December 2010]. Available from: http://www.gulfofmaine.org/.

Gustafson-Greenwood, K. I., and J. R. Moring. 1991. Gravel compaction and permeabilities in redds of Atlantic salmon, *Salmo salar* L. Aquaculture and Fisheries Management 22:537-540.

Gustafson-Marjanan, K. I., and H. B. Dowse. 1983. Seasonal and diel patterns of emergence from the redd of Atlantic salmon (*Salmo salar*) fry. Can. J. Fish.Aquat. Sci. 40: 813-817.

Haeseker, S. L., J. A. McCann, J. Tuomikoski, B. Chockley. 2012. Assessing Freshwater and Marine Environmental Influences on Life-Stage-Specific Survival Rates of Snake river Spring-Summer Chinook Salmon and Steelhead. Transactions of the American Fisheries Society 141:121-138.

Haines, T. A. 1992. New England's rivers and Atlantic salmon. Pages 131-139 in R. H. Stroud (ed.) Stemming the tide of coastal fish habitat loss. National Coalition for Marine Conservation, Savannah, Georgia.

Halvorsen, M. & Svenning, M.-A. 2000. Growth of Atlantic salmon parr in fluvial and lacustrine habitats. J. Fish Biol. 57: 145–160.

Heggenes, J. 1990. Habitat utilization and preferences in juvenile Atlantic salmon (*Salmo salar*) in streams. Regulated Rivers: Research and Management 5(4): 341-354.

Hendry, K., D. Cragg-Hine, M. O'Grady, H. Sambrook, and A. Stephen. 2003. Management of habitat for rehabilitation and enhancement of salmonid stocks. Fisheries Research 62: 171-192.

Herbert, D. W., and J. C. Merkens. 1961. The effect of suspended mineral solids on the survival of trout. International Journal of Air and Water Pollution 5: 46-55.

Hiscock, M. J., D. A. Scruton, J. A. Brown, and C. J. Pennell. 2002. Diel activity pattern of juvenile Atlantic salmon (*Salmo salar*) in early and late winter. Hydrobiologia 483: 161-165.

Hoar W.S. 1988. The physiology of smolting salmon. Pages 275–343 in W.S. Hoar and D.J. Randall (eds.), *Fish Physiology XIB*, Academic Press, New York.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43: 617-627.

Hutchings, J.A. 1986. Lakeward migrations by juvenile Atlantic salmon, *Salmo salar*. Can. J. Fish. Aquat. Sci. 43(4): 732-741.

Hyvarinen, P., P. Suuronen and T. Laaksonen. 2006. Short-term movement of wild and reared Atlantic salmon smolts in brackish water estuary – preliminary study. Fish. Mgmt. Eco. 13(6): 399 –401.

Independent Scientific Advisory Board for the Northwest Power and Conservation Council (ISAB). 2007. Latent Mortality Report: Review of hypotheses and causative factors contributing to latent mortality and their likely relevance to the "Below Bonneville" component of the COMPASS model. *Independent Scientific Advisory Board,* April 6, 2007 (revised June 11, 2007) ISAB 2007-1.

Intergovernmental Panel on Climate Change (IPCC). 2007. Fourth Assessment Report. Valencia, Spain.

Jackson, D. A. 2002. Ecological Effects of Micropterus Introductions: The Dark Side of Black Bass. In Black Bass: Ecology, Conservation, and Management. American Fisheries Society Symposium No. 31:221-232.

Jordan, R.M. and K.F. Beland. 1981. Atlantic salmon spawning and evaluation of natural spawning success. Atlantic Sea Run Salmon Commission. Augusta, ME. 26 pp.

Juanes, F., S. Gephard and K. Beland. 2004. Long-term changes in migration timing of adult Atlantic salmon (Salmo salar) at the southern edge of the species distribution. Canadian Journal of Fisheries and Aquatic Sciences 61: 2392-2400.

Kalleberg, H. 1958. Observations in a stream tank of territoriality and competition in juvenile salmon and trout (*Salmo salar* L. and *S. trutta* L.). Report/Institute of Fresh-Water Research, Drottningholm 39:55-98.

Karl, T., J. Melillo and T. Peterson (Eds.) Global Climate Change Impacts in the United States. 2009. U.S. Global Change Research Program (USGCRP), Cambridge University Press.

Kieffer, M.C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 1221: 1088-1103.Klemetsen, A., P.A. Amundsen, J.B. Dempson, B. Jonsson, N. Jonsson, M.F. O'Connell, and E.

Mortensen. 2003. Atlantic salmon *Salmon salar* (L.), brown trout *Salmo trutta* (L.) and Arctic charr *Salvelinus alpinus* (L.): a review of aspects of their life histories. Ecology of Freshwater Fish 12(1):1-59.

Kleinschmidt Associates. 2010. 2010 Dam survey of the Penobscot and Merrymeeting Bay SHRU. Unpublished data.

Lacroix, G.L. and McCurdy, P. 1996. Migratory behavior of post-smolt Atlantic salmon during initial stages of seaward migration. J. Fish Biol. 49, 1086-1101.

Lacroix, G. L, McCurdy, P., Knox, D. 2004. Migration of Atlantic salmon post smolts in relation tohabitat use in a coastal system. Trans. Am. Fish. Soc. 133(6): pp. 1455-1471.

Lacroix, G. L. and D. Knox. 2005. Distribution of Atlantic salmon (*Salmo salar*) postsmolts of different origins in the Bay of Fundy and Gulf of Maine and evaluation of factors affecting migration, growth and survival. Can. J. Fish. Aquat. Sci. 62(6): 1363- 1376.

Legault, C.M. 2004. Population viability analysis of Atlantic salmon in Maine, USA. Transactions of the American Fisheries Society, 134: 549-562.

Lehodey, P., J. Alheit, M. Barange, T. Baumgartner, G. Beaugrand, K. Drinkwater, J.M. Fromentin, S.R. Hare, G. Ottersen, R.I. Perry. 2006. Climate Variability, Fish, and Fisheries. American Meteorological Society. 19: 5009-5030.

Lloyd, D. S. 1987. Turbidity as a water quality standard for salmonid habitats in Alaska. North American Journal of Fisheries Management 7:34-45.

Lloyd, D. S., J. P. Koenings, and J. D. LaPerriere. 1987. Effects of turbidity in fresh waters of Alaska. North American Journal of Fisheries Management 7:18-33.

Lundqvist, H. 1980. Influence of photoperiod on growth of Baltic salmon parr (*Salmo salar* L.) with specific reference to the effect of precocious sexual maturation. Can. J. Zool. 58(5):940-944.

Maine Department of Inland Fisheries and Wildlife (MDIFW). 2002. Fishes of Maine. Augusta, ME. 38 pp.

Marschall, E.A., T.P. Quinn, D.A. Roff, J. A. Hutchings, N.B. Metcalfe, T.A. Bakke, R.L.Saunders and N.LeRoy Poff. 1998. A Framework for understanding Atlantic salmon (*Salmo salar*) life history. Can. J. Fish. Aquat. Sci. 55(Suppl. 1): 48-58.

McLeay, D.J., G.L. Ennis, I.K. Birtwell, and G.F. Hartman. 1984. Effects on Arctic grayling (Thymallus arcticus) of prolonged exposure to Yukon placer mining sediment: a laboratory study. Yukon River Basin Study. Canadian Technical Report of Fisheries and Aquatic Sciences 1241.

McLeay, D.J., I.K. Birtwell, G.F. Hartman, and G.L. Ennis. 1987. Responses of Arctic grayling, Thymallus arcticus, to acute and prolonged exposure to Yukon placer mining sediment. Can. J. Fish. Aquat. Sci. 44: 658–673.

McCormick, S.F. and R.L. Saunders. 1987. Preparatory physiological adaptation for marine life of salmonids: osmoregulation, growth, and metabolism. Common strategies of anadromous and catadromous fishes. Proceedings of an International Symposium held in Boston, MA, USA, March 9-13, 1986. American Fisheries Society. 1:211-229.

McCormick S.D., L.P. Hansen, T. Quinn, and R. Saunders. 1998. Movement, migration, and smolting of Atlantic salmon (*Salmo salar*). Can. J. Fish. Aquat. Sci. **55**(Suppl. 1): 77-92.

McCormick, S. D., R. A. Cunjak, B. Dempson, M. F. O'Dea, and J. B. Carey. 1999. Temperature-related loss of smolt characteristics in Atlantic salmon (*Salmo salar*) in the wild. Canadian Journal of Fisheries and Aquatic Sciences 56(9): 1649-1658.

McLaughlin, E. and A. Knight. 1987. Habitat criteria for Atlantic salmon. Special Report, U.S. Fish and Wildlife Service, Laconia, New Hampshire. 18 pp.

Meister, A.L. 1958. The Atlantic salmon (*Salmo salar*) of Cove Brook, Winterport, Maine. M.S. Thesis. University of Maine. Orono, ME. 151 pp.

Murdoch, P. S., J. S. Baron, and T. L. Miller. 2000. Potential effects of climate change on surface-water quality in North America. JAWRA Journal of the American Water Resources Association, 36: 347–366

Murphy, B.R. and D.W. Willis, editors. 1996. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

National Assessment Synthesis Team (NAST). 2008. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, http://www.usgcrp.gov/usgcrp/Library/nationalassessment/1IntroA.pdf

National Marine Fisheries Service (NMFS). 2005. Salmon at the River's End: The Role of the Estuary in the Decline and Recovery of Columbia River Salmon. NOAA Technical Memorandum NMFS-NWFSC-68. 279pp.

National Marine Fisheries Service (NMFS). 2009. Endangered and threatened species; designation of critical habitat for Atlantic salmon Gulf of Maine distinct population segment. Federal Register 74 (117): 29300-29341.

National Marine Fisheries Service (NMFS). Atlantic Salmon Recovery Team. 2010. Atlantic salmon recovery framework. Draft.2010. http://www.nero.noaa.gov/prot_res/altsalmon/FrameworkWorkingDraft081110-1.pdf

National Marine Fisheries Service (NMFS). 2011. Atlantic Salmon Fate and Straying at Upstream Fish Passage Facilities on the Penobscot River. Summary of an expert panel convened on December 8, 2010 at the Maine Field Station of the Northeast Regional Office.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2005. Recovery plan for the Gulf of Maine distinct population segment of the Atlantic salmon (*Salmo salar*). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2009. Endangered and threatened species; Determination of endangered status for the Gulf of Maine distinct population segment of Atlantic salmon. Federal Register 74 (117):29344-29387.

National Oceanic and Atmospheric Administration (NOAA). 2010. Internal non-federal database of dams. Unpublished data.

National Science and Technology Council (NSTC). 2008. Scientific Assessment of the Effects of Global Change on the United States. A report of the Committee on Environment and Natural Resources, Washington, DC.

Newcombe, C.P. and T.O.T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16(4): 693-716

Newcombe, C.P., and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. N. Am. J. Fish. Manage. 11:72–82.

Normandeau Associates, Inc. 2011. A review of the Weston Project on the Kennebec River, Maine on Atlantic salmon (*Salmo salar*) smolts and kelt downstream passage and adult upstream passage. Prepared for FPL Energy Maine Hydro, Hallowell, ME. April 2011.

National Research Council (NRC). 2004. Atlantic Salmon in Maine. National Academy Press. Washington, D.C. 304 pp.

O'Connell, M.F. and E.G.M. Ash. 1993. Smolt size in relation to age at first maturity of Atlantic salmon (*Salmo salar*): the role of lacustrine habitat. J. Fish Biol. 42(4):551-569.

Palmer M.A., C.A. Reidy, C. Nilsson, M. Florke, J. Alcamo, P.S. Lake, and N. Bond. 2008. Climate change and the world's river basins: anticipating management options. Frontiers in Ecology and the Environment 6:81-89.

Pepper, V.A. 1976. Lacustrine nursery areas for Atlantic salmon in Insular Newfoundland. Fishereis and Marine Service Technical Report 671. 61 pp.

Pepper, V.A., N.P. Oliver, and R. Blunden. 1984. Lake surveys and biological potential for natural lacustrine rearing of juvenile Atlantic salmon (*Salmo salar*) in Newfoundland. Canadian Technical Report of Fisheries and Aquatic Sciences 1295. 72 pp.

Pizzuto, J. 2002. Effects of dam removal on river form and process. Bioscience 52(8):683-691.

Popper AN, Fay RR, Platt C, Sand O. 2003. Sound detection mechanisms and capabilities of teleost fishes. In: Collin SP, Marshall NJ (eds) Sensory Processing in Aquatic Environments. New York: Springer-Verlag, pp. 3–38.

Randall, R.G. 1982. Emergence, population densities, and growth of salmon and trout fry in two New Brunswick streams. Can. J. Zool. 60(10):2239-2244.

Reddin, D.G. 1985. Atlantic salmon (*Salmo salar*) on and east of the Grand Bank. J. Northwest Atl. Fish. Soc. 6(2):157-164.

Reddin, D.G. 1988. *Ocean* life of Atlantic salmon *(Salmo salar L.*) in the Northwest Atlantic. pp. 483 – 511. in D. Mills and D. Piggins [eds.] *Atlantic Salmon: Planning for the Future.* Proceedings of the 3rd International Atlantic Salmon symposium.

Reddin, D.G and K.D. Friedland. 1993. Marine environmental factors influencing the movement and survival of Atlantic salmon. 4th Int. Atlantic Salmon Symposium. St. Andrews, N.B. Canada.

Reddin, D.G. and W.M. Shearer. 1987. Sea-surface temperature and distribution of Atlantic salmon in the Northwest Atlantic Ocean. Am. Fish. Soc. Symp.

Reddin, D.G and P.B. Short. 1991. Postsmolt Atlantic salmon (*Salmo salar*) in the Labrador Sea. Can. J. Fish Aquat. Sci.. 48: 2-6.

Reddin, D.J., D.E. Stansbury, and P.B. Short. 1988. Continent of origin of Atlantic salmon (*Salmo salar* L.) caught at West Greenland. Journal du Conseil International pour l'Eploration de la Mer, 44: 180-8.

Redding, J.M., C.B. Shreck, and F.H. Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Transactions of the. American Fisheries Society 116: 737–744.

Riley, W.D., D.L. Maxwell, M.G. Pawson, and M.J. Ives. 2009. The effects of low summer flow on wild salmon (Salmo salar), trout (Salmo trutta), and grayling (Thymallus thymallus) in a small stream. Freshwater Biology 54: 2581-2599.

Ritter, J.A. 1989. Marine migration and natural mortality of North American Atlantic salmon *(Salmo salarL.)*. Can. MS Rep. Fish. Aquat. Sci.. No. 2041. 136 p.

Ruggles, C.P. 1980. A review of downstream migration of Atlantic salmon. Canadian Technical Report of Fisheries and Aquatic Sciences. Freshwater and Anadromous Division.

Scannell, P. O. 1988. Effects of elevated sediment levels from placer mining on survival and Behavior of immature arctic grayling. Alaska Cooperative Fishery Unit, University of Alaska. Unit Contribution 27.

Schaffer, W.M. and P.F. Elson. 1975. The adaptive significance of variations in life history among local populations of Atlantic salmon in North America. Ecology 56:577-590.

Schaller, H. A. and C. E. Petrosky. 2007. Assessing hydrosystem influence on delayed mortality of Snake River Stream-Type Chinook salmon. North American Journal of Fisheries Management 27:810–824.

Scott, W.B. and E.J. Crossman. 1973. Atlantic salmon. Pages 192-197 in Freshwater Fishes of Canada (Bulletin 184). Department of Fisheries and Oceans, Scientific Information and Publications Branch, Ottawa.

Servizi, J.A., and D.W. Martens. 1991. Effect of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon, Oncorhynchus kisutch. Canadian Journal of Fisheries and Aquatic. Sciences. 48: 493–497.

Shelton, R.G.J., J.C. Holst, W.R. Turrell, J.C. MacLean, I.S. McLaren. 1997. Young Salmon at Sea. In Managing Wild Atlantic Salmon: New Challenges – New Techniques. Whoriskey, F.G and K.E.Whelan. (eds.). Proceedings of the Fifth Int. Atlantic Salmon Symposium, Galway, Ireland.

Shortnose Sturgeon Status Review Team. 2010. A Biological Assessment of shortnose sturgeon (Acipenser brevirostrum). Report to National Marine Fisheries Service, Northeast Regional Office. November 1, 2010. 417 pp.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and Coho salmon. Transactions of the American Fisheries Society. 113: 142-150.

Snyder, D.E. 2003. Electrofishing and its harmful effects on fish. Information and Technology Report USGS/BRD/ITR-2003-0002. U.S. Government Printing Office, Denver, CO. 149 pp.

Spence, B.. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis OR. (Available from the National Marine Fisheries Service, Portland, Oregon.)

Spidle, A.P., S.T. Kalinowski, B., A. Lubinski, D.L. Perkins, K.F. Beland, J.F. Kocik, and T.L. King. 2003. Population structure of Atlantic salmon in Maine with references to populations from Atlantic Canada. Trans. Am. Fish. Soc. 132:196-209.

Stadler, J and D.P Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. Internoise 2009: Innovations in practical noise control. Ottawa, Canada. August 23-26 2009.

Swansburg, E., G. Chaput, D. Moore, D. Caissie, and N. El-Jabi. 2002. Size variability of juvenile Atlantic salmon: links to environment conditions. J. Fish Biol. 61: 661-683.

Taubert, B.D., and M.J. Dadswell. 1980. Description of some larval shortnose sturgeon (Acipenser brevirostrum) from the Holyoke Pool, Connecticut River, Massachusetts, USA, and the Saint John River, New Brunswick, Canada. Canadian Journal of Zoology 58:1125-1128.

Trial, J.G. 2012. February 3, 2012 letter to Laury Zicari (Service) documenting Maine Department of Marine Resources (MDMR) activities authorized under Regional Endangered Species blanket permit #697823 for the take of Atlantic salmon under the Endangered Species Act during 2011 activities.

Turnpenny, A W. H., K. P Thatcher, and J. R Nedwell. 1994. The effects on fish and other marine animals of high-level underwater sound." Report FRR 127/94, Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.

U.S. Army Corps of Engineers (USACE). 2005. National inventory of dams. [Internet]. [cited 19 January 2011]. Available from: http://www.usace.army.mil/Library/Maps/Pages/National InventoryofDams.aspx.

U.S. Atlantic Salmon Assessment Committee (USASAC). Annual reports between 2001 and 2012. Annual Report of the U.S. Atlantic Salmon Assessment Committee.

U.S. Fish and Wildlife Service (USFWS). 2012a. Draft Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*). April 2012. 142 pgs.

U.S. Fish and Wildlife Service (USFWS). 2012b. Technical Memorandum: Assumptions Used and Verification Process for the Development of the Black Bear Hydro Species Projection Plan. Maine Field Office, Orono, Maine. 66 pgs.

Van den Ende, O. 1993. Predation on Atlantic salmon smolts (*Salmo salar*) by smallmouth bass (*Micropterus dolomeiu*) and chain pickerel (*Esox niger*) in the Penobscot River, Maine. M.S. Thesis. University of Maine. Orono, ME. 95 pp.

Whalen, K. G., D. L. Parish, and M. E. Mather. 1999. Effect of ice formation on selection habitats and winter distribution of post-young-of-the-year Atlantic salmon parr. Can. J. Fish. Aquat. Sci. 56(1): 87-96.

Wheaton, J. M., G. B. Pasternack, and J. E. Merz. 2004. Spawning habitat rehabilitation-I. Conceptual approach and methods. International Journal of River Basin Management 2(1): 3-20.

White, H.C. 1942. Atlantic salmon redds and artificial spawning beds. J. Fish. Res. Bd. Can. 6:37-44.

Windsor, M. L., P. Hutchinson, L.P. Hansen and D. G. Reddin. 2012. Atlantic salmon at sea: Findings from recent research and their implications for management. NASCO document CNL(12)60. Edinburgh, UK. 20pp.

Wood, H., J. Spicer and S. Widdicombe. 2008. Ocean acidification may increase calcification rates, but at a cost. Proceedings of the Royal Society: Biological Sciences 275, no. 1644: 1767-1773.

Wright, J., J. Sweka, A. Abbott, and T. Trinko. 2008. GIS-Based Atlantic Salmon Habitat Model. *Appendix C in*: NMFS (National Marine Fisheries Service). 2008. Biological valuation of Atlantic salmon habitat within the Gulf of Maine Distinct Population Segment. NOAA National Marine Fisheries Service, Northeast Regional Office, Gloucester, MA.

Wysocki, L.E., J.W. Davidson III, M.E. Smith, A.S. Frankel, W.T. Ellison, P.M. Mazik, A.N. Popper, J. Bebak. 2007. Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout Oncorhynchus mykiss. Aquaculture 272:687–697