NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: NOAA's Restoration Center
Federal Energy Regulatory Commission
US Army Corps of Engineers, New England District
US Fish and Wildlife Service, Region 5

Activity Considered: Re-Initiation of Consultation concerning decommissioning of the Veazie (No. 2403) and Howland (No. 2721) Projects

NER-2012-918

Conducted by: National Marine Fisheries Service
Northeast Region

Date Issued: 11/29/12

Approved by: for John Bullard

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1. INTRODUCTION AND BACKGROUND

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.), requires that each Federal agency insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a Federal agency may affect species listed as endangered or threatened under the ESA, that agency is required to consult with either NOAA's National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS), depending upon the species that may be affected. In instances where NMFS or USFWS are themselves authorizing, funding, or carrying out an action that may affect listed species, the agency must conduct intra-service consultation. Since actions described in this document are funded by the NMFS' Restoration Center (RC) and may affect NMFS listed species, we are conducting a formal intra-service section 7 consultation.

As part of the American Recovery and Reinvestment Act (ARRA) of 2009, the RC provided significant funding to the Penobscot River Restoration Trust (Trust) to support dam decommissioning and removal activities in the Penobscot River. Starting in 2010 and continuing today, the Trust has used these funds to support the removal of the Veazie Project (No. 2403), the Great Works Project (No. 2312), and decommissioning and construction of the fish bypass at the Howland Project (No. 2721). Formal ESA section 7 consultation for these activities was initiated by the Federal Energy Regulatory Commission (FERC) on August 12, 2009 and completed by us on December 23, 2009 with the issuance of a Biological Opinion (Opinion) (F/NER/2009/01515). The Opinion concluded that these actions were likely to adversely affect but not likely to jeopardize the continued existence of endangered Atlantic salmon and shortnose sturgeon. In addition to the RC, several federal agencies including FERC, US Army Corps of Engineers (ACOE), and the FWS undertook actions to authorize, fund or carry out the removal of the Veazie and Great Works Projects and decommissioning and construction of the fish bypass at the Howland Project. These activities are ongoing. Our 2009 Opinion considered the total effects of all these agency activities on listed species in the Penobscot River.

We have reinitiated this consultation to consider effects to newly listed Distinct Population Segments (DPS) of Atlantic sturgeon from related and ongoing activities authorized by FERC and the ACOE and proposed to be funded by the RC. In addition, we consider new information on Atlantic salmon and shortnose sturgeon that has become available since the issuance of our 2009 Opinion. By issuing this Opinion, we withdraw the Opinion dated December 23, 2009. This Opinion is based on information provided in FERC's initiation letter and attached Biological Assessment (BA) submitted on August 12, 2009, the original December 23, 2009 Opinion, and other sources of information as cited throughout. A complete administrative record of this consultation will be kept on file at our Maine Field Office in Orono, Maine.

1.1. Consultation History

- **November 7, 2008 -** The Trust's application for dam decommissioning was submitted to FERC.
- **January 8, 2009 -** The Trust requested to be a non-federal representative for informal section

7 consultation.

- **February 17, 2009 -** Representatives from the Trust met in Orono, Maine with USFWS and us to discuss preparation of the draft Biological Assessment (BA).
- **March 23, 2009 -** Letter sent from Trust to us requesting updated species lists for purposes of carrying out informal section 7 consultation and preparation of draft BA.
- **April 3, 2009 -** Letter sent from us to Trust containing updated species list and guidance on preparation of draft BA.
- **April 13, 2009 -** Representatives from the Trust met in Orono, Maine with us to discuss content of draft BA.
- **June 9, 2009 -** Representatives from the Trust met with us at our Regional Headquarters in Gloucester, Massachusetts to discuss scope of the proposed action and operations of the Projects prior to dam removal.
- **June 12, 2009** - Representatives from the Trust met in Orono, Maine with us and USFWS to discuss draft BA.
- **June 22, 2009-** Representatives from the Trust met in Orono, Maine with us and USFWS to discuss operations of the Projects prior to dam removal.
- **August 12, 2009 -** FERC requested formal consultation with us pursuant to section 7 of the ESA for decommissioning of the Veazie, Great Works, and Howland Projects.
- **September 3, 2009 -** We indicated in a letter to FERC that all information necessary to initiate formal section 7 consultation was included with FERC's August 12, 2009 letter.
- **December 23, 2009 -** We issued our Biological Opinion regarding the proposed actions.
- **June 16, 2010 –** FERC issued an order approving the Trust's application for surrender of the licenses for the Veazie, Great Works, and Howland Projects.
- **April 29, 2012 -** Representatives from the Trust and affected municipalities met in Bradley, Maine with us to discuss pre-construction coordination.
- **May 2, 2012 -** Representatives from the Trust and contractors met in Old Town, Maine with us to discuss anticipated acoustic impacts and monitoring requirements.
- **May 30, 2012 -** NOAA RC, acting as the lead Federal agency for purposes of this consultation, on behalf of the other action agencies, requested re-initiation of consultation due to the listing of five DPSs of Atlantic sturgeon.
- **June 4, 2012 -** We reinitiated consultation per the request of the NOAA RC, and as stipulated in 50 CFR §402.16 (d)

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 FERC's August 12, 2009 BA in support of formal consultation under the ESA; 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*). On February 6, 2012, we published notice in the *Federal Register* listing the Atlantic sturgeon as "endangered" in the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs, and as "threatened" in the Gulf of Maine DPS (77 FR 5880 and 77 FR 5914).

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, as directed by the consultation regulations:

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

In completing the last step, we determine whether the action under consultation is likely to jeopardize the ESA-listed species or result in the destruction or adverse modification of designated critical habitat. If so, we must identify a reasonable and prudent alternative(s) (RPA) to the action as proposed that avoids jeopardy or adverse modification of critical habitat and meets the other regulatory requirements for an RPA (see 50 CFR §402.02). In making these determinations, we must rely on the best available scientific and commercial data.

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 (Gifford Pinchot Task Force *et al.* v. U.S. Fish and Wildlife Service, No. 03-35279, August 6, 2004).

2. PROJECT DESCRIPTION AND PROPOSED ACTION

To help restore diadromous fish species in the Penobscot River watershed, the Trust filed applications with the FERC on November 7, 2008 to surrender the licenses of the Veazie, Great Works, and Howland Projects pursuant to the terms of the Lower Penobscot River Basin Comprehensive Settlement Accord (Settlement). The Settlement, signed by multiple state and federal agencies and non-governmental organizations, provided the Trust the option to purchase the Veazie, Great Works, and Howland Projects and obtain their licenses for the purpose of surrendering these licenses, decommissioning and removing the Veazie and Great Works Projects and decommissioning the Howland Project and building a fish bypass around it. The Trust’s application is part of the larger Penobscot River Restoration Project (PRRP) to restore diadromous fish species to the Penobscot River watershed. The Trust is a non-profit organization created in May 2004 for the purpose of carrying out certain aspects of the Settlement.

On June 16, 2010, the FERC issued orders to surrender the licenses of the Veazie, Great Works, and Howland Dams. The order also approved the decommissioning of these facilities. The Trust commenced dam removal activities at the Great Works Project in June 2012 and the dam has been completely removed. The Trust continues to use ARRA monies granted by the RC to complete restoration activities at the three dams. The RC also anticipates providing additional funds to the Trust in 2013. Since the RC retains discretionary Federal agency involvement over the Trust’s activities associated with the PRRP, you are identified as the lead Federal agency for the proposed actions under consideration in this reinitiation of formal consultation.

This reinitiated Opinion only addresses the components of the proposed action that have yet to occur. Therefore, the removal of the Great Works Dam will not be considered, as it was addressed in the original consultation and has already been removed. The original Opinion issued in 2009 addressed the effects of a six year interim period where the Veazie and Howland Projects would continue to operate prior to decommissioning. This consultation will address Project operations over the remaining three years of the interim period, as well as the removal of the Veazie Dam and the construction of a nature-like fish bypass around the Howland Dam.

2.1. Existing Hydroelectric Facilities and Operations

Veazie Project

The Veazie Project is located in the towns of Veazie, Eddington, Orono, and Bradley in Penobscot County, Maine (Figure 1). The Veazie Dam is the lowermost dam on the Penobscot River (located at approximately river kilometer 47), and forms the current head-of-tide. The dam was constructed in 1910. The project operates under the terms of the license issued on April 20, 1998 for a term of 40 years. The dam creates an impoundment that extends upstream for 6.1 kilometers and covers 157.8 surface hectares. The Veazie spillway consists of a 19.5 meter long gravity concrete segment near its left abutment and a main 148.4 meter long concrete buttress segment with a maximum height of 9.7 meters. Other structural features include a 70.1 meter long masonry forebay wall, two fishways, and a 19.8 meter long radial gate structure. The main spillway is an Ambursen-type design built in 1913. The two fish passage facilities include an abandoned concrete fishway located at the eastern end of the dam, and an active vertical slot fishway and trap situated near the powerhouse forebay between the overflow sections. The vertical slot fishway (including the trap) is owned and operated by the state of Maine. A bypass weir for passing downstream migrating diadromous fish is also present at the project.

The site has two powerhouse buildings (Station A and Station B), an electrical substation, a river-crossing cable car structure, and two additional supporting structures. The Station A powerhouse contains 15 turbine-generator units with a total installed capacity of 5.4 megawatt (MW). The Station B powerhouse is located immediately south of Station A, and contains two turbine-generators with a total installed capacity of approximately 3.0 MW.

The Veazie Project is operated as a run-of-river facility and the dam is not used for flood control or water supply. When inflows are less than 212 cubic meters per second (cms) (7,500 cubic feet per second (cfs)), the station A and B powerhouses are operated based on available flows, fish passage considerations, and maintenance requirements. At inflows of less than 212 cms, all water passes through the powerhouses. When inflows are more than 212 cms, all units are on-line and water in excess of the total turbine capacity passes over the spillway.

Although not part of the licensed project works at Veazie, an older dam remnant lies submerged in the headpond just upstream of the main spillway. The relic dam was used in previous industrial uses of the Penobscot River.

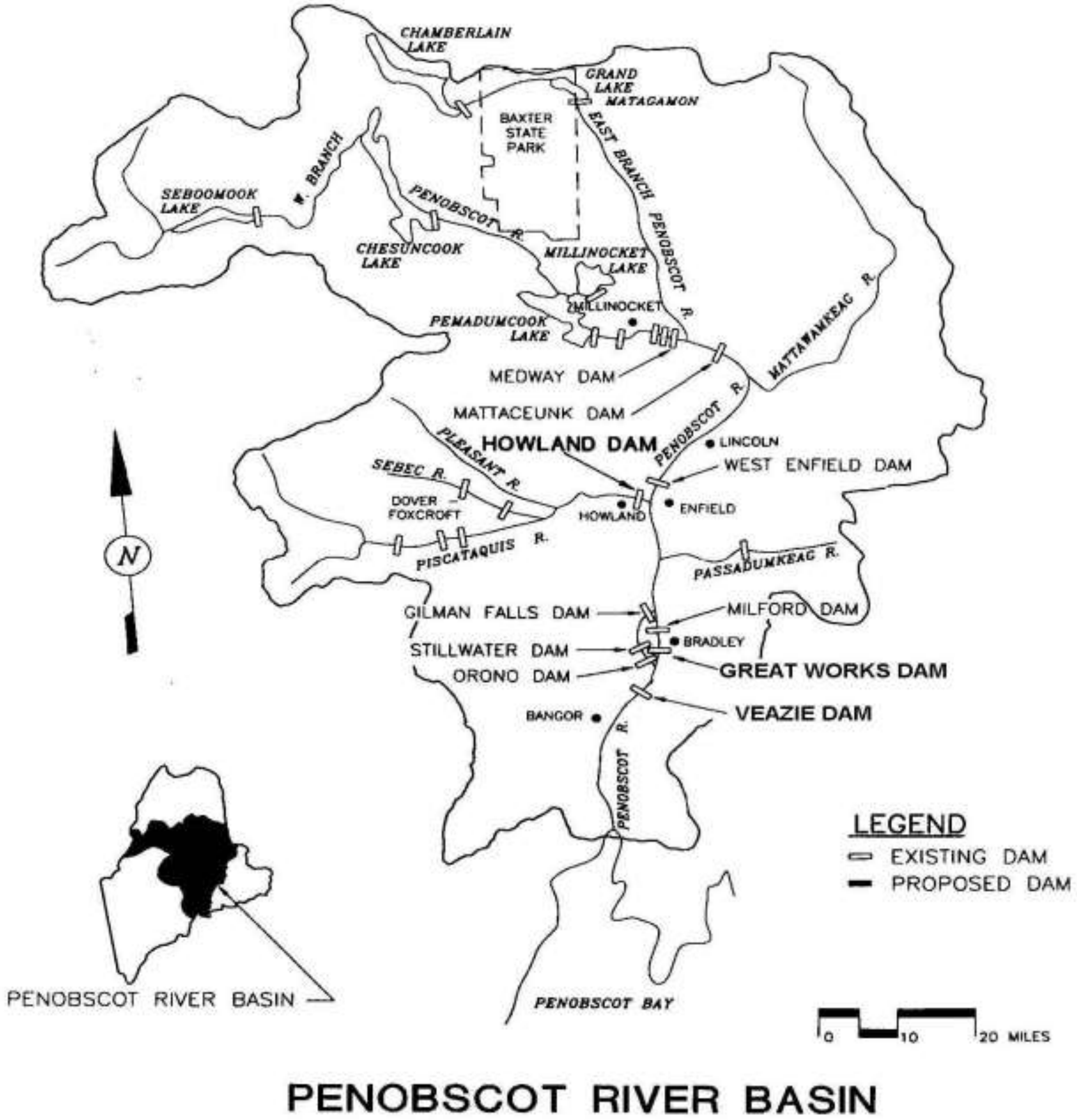

Figure 1. Penobscot River basin, tributaries, and dams.

Howland Project

The Howland Project is located on the Piscataquis River, approximately 152 meters upstream of its confluence with the Penobscot River (Figure 1). The Project is contained within the town of Howland in Penobscot County. The dam creates a 109.3 surface hectare impoundment that is 7.6 kilometers in length.

The Howland Dam consists of a 34.9 meter long concrete cutoff wall at the north embankment of the dam, a 1.8 meter long non-overflow abutment, a 173.7 meter long concrete overflow spillway, an 25.9 meter long section containing a gated spillway section with four 2.7 meter by 2.7 meter steel roller flood gates, a 6.1 meter long non-overflow spillway, and a 23.2 meter long forebay entrance deck located immediately upstream of the powerhouse. The Project has two fishways – an abandoned fishway located adjacent to the flood gates, and an operating Denil-design fish ladder built in 1965, which is situated next to the powerhouse in a non-overflow section of the spillway. A bypass weir for passing downstream migrating diadromous fish is also present at the project. The powerhouse contains three generating units, which have a total combined generating capacity of 1,875 kilowatts. The project is operated as a run-of-river facility with a total hydraulic capacity of 48.4 cubic meters per second (1710 cfs).

2.2. Proposed Action

NOAA's RC proposes to continue funding the Trust to remove the Veazie dam and decommission the Howland Project to build a fish bypass around it. These activities will be carried out as authorized by FERC and the ACOE. This Opinion analyzes the effects of these activities on listed species under our jurisdiction.

2.2.1. Pre-Removal Activities

The Trust will continue to operate the Veazie and Howland Projects to generate revenue needed for removing the dams or constructing the fish bypass. The Veazie Dam is expected to be removed no later than 2014. It is presently unknown how long the Trust will need to operate the Howland Project prior to raising sufficient funding for removal and construction of the fish bypass. Based on the best available information and for purposes of this Opinion, we assume that interim operations at the Veazie and Howland Projects will occur for no longer than three years following issuance of this Opinion.

Currently, the Veazie and Howland Projects are operated pursuant to the terms and conditions of existing FERC licenses. To protect listed Atlantic salmon and other aquatic resources in the Penobscot River, the Trust implements turbine shutdowns in the spring at the Veazie and Howland Projects. The turbine shutdowns at Veazie and Howland are implemented as follows:

Dates/times for turbine shutdowns:	May 7 – May 20; 8:00 PM – 4:00 AM Daily
No. of units shutdown at each project:	Veazie: 16 of 17 Howland: 2 of 3

2.2.2. Removal Activities Overview

Removal of the Veazie Dam will, at a minimum, require one construction season, but may require two. The main dam at Veazie will be removed during the first season; the upstream remnant dam will likely need to be removed thereafter. While the Trust is presently developing its final design for removal of Veazie Dam, it anticipates using mechanical demolition (as opposed to blasting) as the major activity. This technique was used successfully in the removal of the Edwards (FERC No. 2389), Sandy River (FERC No. 11433), Fort Halifax (FERC No. 2552), and Great Works (FERC No. 2312) Projects in Maine. Details on access road construction, sediment and erosion control, and re-vegetation procedures were included in the

Trust's surrender applications, and are attached to FERC's original BA. The timing of construction of the fish bypass at the Howland Project will likely occur during summer low flows, but is not restricted by removal of the Veazie Project. The Trust will receive funding from the RC to complete these activities; therefore, they are considered as part of the proposed action.

Prior to dam removal activities at the Veazie Project, the impoundment will be lowered to reduce the amount of in-stream work and to facilitate access to project structures. The initial draw-down phases at the Veazie Dam can proceed as soon as flows in the Penobscot River drop in the summer to around 169.9- 198 cubic meters per second (6,000 to 7,000 cfs). The date associated with this low flow will vary by year, but will likely begin in late June to early July. Since the Howland Dam will remain in place, an impoundment drawdown is not required. During consultation on the draft applications for license surrenders, state and federal fisheries agencies indicated that drawdown of the Veazie Dam should not occur until at least July 1 in order to protect spawning sturgeon, and to allow for the majority of the upstream Atlantic salmon migration to occur. The Trust has agreed not to begin any in-water work until July 1 of each year. Work will continue until river conditions become unsuitable due to icing in the early winter (likely early December). To protect listed Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon, the Trust proposes to commence dam removal activities at the Veazie Dam after July 1.

The following provides specific descriptions of the proposed construction plans at the Veazie and Howland Projects.

2.2.2.1.*Veazie Project*

The Trust will disconnect the generator units from the grid, and remove the spillway section of the dam, the eastern fishway, the concrete forebay, and tailrace tunnels associated with Powerhouse A (Powerhouse A will remain intact), the cableway system, and Powerhouse B. The Trust will also remove several piers and remnants of a wing dam located in the Veazie impoundment. Removing the spillway dam will lower the impoundment elevation approximately 6.2 meters during the August median flow near the dam. Once the impoundment is lowered, the fishway at Veazie Dam will no longer be operable. Therefore, the Trust will work to immediately breach a section of the spillway to resume upstream passage for Atlantic salmon. Removal of other in-stream structures will then follow.

To complete the project, the Trust will need to place temporary fill in the Penobscot River to facilitate construction/demolition access but all fill will be removed following completion of the project. All fill and demolition will be removed and disposed in accordance with applicable state and federal regulations. It is anticipated that 11,468.3 cubic meters (15,000 cubic yards) of temporary fill covering an area approximately 5 hectares (12.27 acres) will need to be placed in the Penobscot River to remove the Veazie Dam. Details of the dam removal are provided below. As explained above, all in-water work associated with dam removal will begin in the summer low flow period (July 1 or later) and continue through ice-in (early December). Temporary fill will serve as both access roads and cofferdams to isolate discrete work areas.

Removal Activities Overview

Spillway and Abutments – The primary buttress spillway at Veazie Dam will be removed, including the eastern gravity spillway section. The east abutment of the Veazie Dam, which is comprised of rock with heavily vegetated surficial soil cover, will be removed except for the footing. The west abutment has two sections and will remain.

Existing Power Stations and Forebay – The original powerhouse, Station A, is a wood and masonry structure containing 15 turbine-generator units. This powerhouse is located on the west bank adjacent to the river channel, and is entirely on the upland. Station A will be retained, as it does not affect hydraulics or fish passage.

Power Station B is a brick and concrete structure located immediately downstream of Station A, and protrudes into the river channel. It contains two turbine-generator units. Station B and the concrete forebay and tailrace tunnels associated with Station A will be removed.

Upstream Dam Remnants - Remnants of a 19th century dam are located beneath the current water surface upstream of the Veazie Dam. The dam is "V" shaped along its lowermost portion with a 90° bend at the upper portion. Based upon a review of aerial photographs, old drawings, and subsurface soundings, these remnants are believed to be comprised of a dam across about 1/3 of the river up to 6.1 meters high connected to a 579.1 meter (1900 feet) longitudinal wing dam extending parallel to flow approximately 73.2 meters (240 feet) upstream of the powerhouse east side forebay. The structure is presently submerged under 1.5- 2.7 meters (five to nine feet) of water.

Due to its likely effect on future hydraulic conditions, portions of the upstream remnant dam structure will be removed. This will require access roads and sediment/water control separate from that required for the removal of the downstream Veazie Dam.

Aerial Cableway – An aerial cableway runs across the river parallel to the Veazie Dam. It is used during flashboard installation at the dam and to provide access to the fishway. The cableway will be removed, including dismantling and disposal of the metal towers and cables and cable car.

Fishways – Two concrete fishways are present at the Veazie Project. An abandoned concrete fishway is located at the eastern end of the dam, and an active vertical slot fishway and trap facility is located near the powerhouse forebay between the overflow sections. Both fishways will be removed.

Disposal of Materials – Construction debris will consist of concrete, stone fill, and large timber. Removal of the dam will generate approximately 6651.6 cubic meters (8,700 cubic yards) of concrete (much of which is likely to be steel reinforced) and approximately 1,223.3 cubic meters (1,600 cubic yards) of gravel, stone fill and wood cribbing. The volume of material associated with the old mill dam remnants is unknown. Concrete and stone fill can be processed to finer aggregate and reused at the contractor's discretion. The timber elements will require landfill disposal, or may be used for alternative energy reuse. Steel and other metals will be recycled or disposed of at appropriate off-site facilities.

Detailed Work Plan

Phase I-Site Preparation

In this phase, the turbines will be removed from the two powerhouses. The construction access route will be prepared from the east and west banks of the river. Erosion controls and staging areas will be established and a downstream debris boom will be installed. Site preparation, including removal of the turbines, is expected to take up to four weeks.

Phase II-Water Control, East Bank Dam, and Fishway Removal

During the second phase of construction, the following steps will be taken:

- Open all powerhouse gates to drawdown the pool (approximately two weeks);
- Lower/deflate the flashboard system;
- Construct the eastern bank access road along an existing unpaved access way. This road will extend to the abandoned fishway structure on the eastern shore;
- Remove the gravity section of the dam;
- Remove east bank cableway towers and cables, with footings to remain;
- Extend the east bank access road upstream and along the backside of the dam, to 97.5 meters from the eastern extent of the maximum buttress section;
- Extend the east bank access road downstream along the face of the dam to create a temporary access road approximately 6 meters wide and extending approximately 137 meters from the shore;
- Breach the easternmost section of the spillway (approximately 975 meters long) and remove the spillway from west to east; and,
- If necessary, re-grade channel at the dam for fish passage.

Construction of the access roads will require the placement of stone fill into the river both upstream and downstream of the dam. Work downstream of the dam is expected to occur largely in the dry as downstream river flow will flow through the powerhouse, which is located on the west bank. Work upstream of the dam will occur in the wet. Equipment to be used for spillway breaching and removal will be staged from the access road. The spillway is expected to be removed with mechanical means (jackhammer, hoe ram, excavator, etc.) and no blasting has been proposed.

Once the eastern portion of the spillway is removed, the upstream and downstream access roads will be removed which will allow water to flow downstream in the newly removed dam section. The Trust estimates that it will take approximately four to six weeks from the time the impoundment is lowered until a breach is achieved on the east end of the spillway.

Phase III – West Bank Dam, Forebay, and Powerhouse B Removal

Following the removal of the eastern section of the spillway and the removal of the in-river eastern access roads, the next phase will begin. Phase III will include the following activities:

- Extend the west bank access road approximately 213.4m from the shoreline into the river upstream of the dam;
- Remove the forebay, tailrace tunnel walls, gates and powerhouse B;
- Remove the existing fishway;
- Remove the spillway from east to west;
- If necessary, re-grade the channel at the dam for fish passage;
- Remove any remnants of the old cofferdam present between the access road and the dam; and,
- Remove the in-river portion of the west bank access road.

Construction of the access roads will require the placement of stone fill into the river upstream of the dam. During this phase, downstream river flow will be concentrated along the east bank where the dam has been breached. This will allow construction of the access road to occur in the dry. Equipment to be used for spillway breaching and removal will be staged from the access road. The spillway is expected to be removed with mechanical means (jackhammer, excavator, etc.) and no blasting has been proposed.

Phase IV – West Bank Site Improvements

Following the removal of the west portion of the spillway, west bank site improvements will begin. In this stage the west bank access road will be extended along the face of the powerhouse (adjacent to the shoreline), the remaining tailrace tunnels under the powerhouse will be filled with concrete and a wall will be constructed along the face of Powerhouse A to seal it. Because downstream river flow will be concentrated along the east portion of the channel, the concrete work at the powerhouse will be carried out in the dry. The banks will be graded and stabilized at the former powerhouse B and the west bank access road will be removed.

Phase V – Upstream Structure Removal

The last phase of removing the Veazie Project will involve the removal of the remnant mill dam. Steps to be completed under this phase are:

- Construct access road along exposed east bank to upstream of perpendicular dam section. The access road will extend approximately 304m along the shoreline and then extend approximately 114m towards the middle of the river;
- Remove the perpendicular section of the remnant dam from west to east;
- Remove the east bank access road;
- Construct access road extending approximately 114m from the west bank and remove section of the dam structure accessible from this road;
- Construct T-shaped access road from west bank and remove section of the dam structure accessible from this road;
- Construct additional section of west bank access road and remove section of the dam

structure accessible from this road;

- Remove any old structures (i.e., piers, etc) from the upstream pool areas as needed;
- Implement landscape restoration plans and remove west bank access roads; and,
- Remove debris boom and excess debris.

Construction of the east bank access road will require work in the wet. However, once the access road is built, flow will be diverted to the west shore and dam removal activities will proceed largely in the dry. Construction of west shore access roads is expected to occur in the dry as the eastern portions of the dam will have been removed and river flow will be along the eastern shore.

2.2.2.2.*Howland Project*

The Trust will remove the turbines, disconnect the generator units from the grid, permanently remove the flashboards, remove on-site buildings as necessary, construct a new site access road and bridge, and construct a fish bypass at the site. The Howland Dam will be retained and maintained and the existing eight foot wide sluice gate will be replaced with a crest overflow gate to facilitate downstream passage of fish. The Trust also proposes to construct a fish bypass around the project site for upstream and downstream passage of diadromous fish in the Piscataquis River. Removing the flashboards will permanently lower the impoundment elevation by 1.2 meters at the dam during the August median flow.

The fish bypass is designed to pass upstream and downstream diadromous fish around the Howland Dam. The fish bypass would be located along the south bank of the Piscataquis River. The bypass will be approximately 213 meters in length with an average base width of 22.9 meters and a low flow channel typically 3.7 to 7.7 meters wide. Flow to the bypass will be controlled through eight bays (box culverts) with stop logs. The fish bypass will have a slope of 1.5% with slight variations to create low flow pools. The fish bypass is designed to operate under flows from 300 to 9,000 cubic feet per second (cfs) in the Piscataquis River. The downstream half of the bypass will be built in an area of bedrock excavation, while the upstream half will have an earthen cut. For the earth channel, a stone riprap base will be required for stability, with boulders and boulder clusters added to create roughness and shelter for fish. A low flow channel will be built with a series of pools to provide resting areas. Top soil and plantings will be provided on the channel sides. A bridge will be placed over the bypass to provide permanent access to the powerhouse and fish bypass. No temporary or permanent fill will be placed in the Piscataquis River during construction of the fish bypass.

Surrender Activities Overview

Dam, Flashboards, and Gates-The Howland Dam will remain in place, with its four main sluice flood gates and related structures also remaining. The turbines will be removed from the powerhouse. The wooden flashboards, which are periodically washed out by floods, will be permanently removed. Thus, the future pool elevation will be equal to the concrete spillway crest. The 2.4 meter wide sluice gate that regulates flow to the existing fish ladder and log sluice will be replaced with a crest overflow gate to allow downstream fish passage. The turbines will be removed from the powerhouse.

Buildings – Several abandoned buildings are present in the vicinity of the Howland Project. These buildings must be removed prior to installation of the proposed fish bypass at the project. Two buildings will be completely removed while a third building will be partially removed.

Fish Bypass – A fish bypass will be constructed around the Howland Project to allow upstream and downstream passage of diadromous fish species in the Piscataquis River. The entrance to the bypass will be located immediately adjacent to the existing powerhouse at a 45 degree angle. The centerline of the bypass will be 30.5 meters downstream (east) of the powerhouse. The fish bypass exit (which is the hydraulic inlet) will be located 182.9 meters upstream of the powerhouse on the south bank of the Piscataquis River.

Site Access – Permanent access to the powerhouse and left (north) bank of the bypass channel will be achieved with a new driveway parallel to the river bank. The access road will be raised to protect the bypass channel from lateral flood flows. The access road to the powerhouse will span the bypass channel via a series of concrete cast-in-place box culverts. The structures will have cobbles grouted into their invert to provide roughness and will be depressed to concentrate low flow. These culverts will serve a critical role in regulating flow into the bypass channel. A cut-off wall will be required beneath the culverts to accommodate seepage forces.

Detailed Work Plan

Phase I – Site Preparation and Building Demolition

Erosion controls will be placed on the site and upland areas will be cleared and grubbed in preparation for building demolition and bypass channel construction. Overhead electrical utilities will also be removed during this phase of work in preparation for bypass channel construction. At the end of this phase of work, the flashboards will be removed from the dam and flood gates will be opened to lower water levels.

Phase II – Powerhouse Access Road Construction

Under this phase of work, the cutoff wall will be installed along the centerline of the proposed powerhouse access road and grading of the access road will be completed. This phase of work is anticipated to take four weeks to complete.

Phase III – Bypass Channel Crossing

Under the third phase of construction, the proposed bypass channel bridge crossing will be constructed, including foundations, abutment walls, parapet walls, and box culverts. This works occurs before completion of the bypass channel, and will therefore be in the dry. The access road over the culverts will then be completed. This phase of work is anticipated to take eight to ten weeks to complete.

Phase IV – Bypass Channel Excavation

Under this phase of work, the bypass channel will be constructed, beginning near the fishway entrance (downstream section) and continuing upstream along the channel alignment. The excavation will stop short of the fishway entrance and exit to prevent water from entering the channel during completion of construction activities. This phase of work is anticipated to take twelve weeks to complete.

Phase V – Bypass Channel Completion

Under this phase of work, in-channel features will be constructed, including linings, modified J-hook vanes, boulder placement, and plantings. The final element of the bypass channel construction will be to connect the downstream segment and then the upstream segment to the Piscataquis River. This phase of work is anticipated to take six weeks to complete.

2.2.2.3.*Construction Protective/Mitigation Measures*

The purpose of providing RC funds to the Trust is to restore diadromous fish species to the Penobscot River watershed. Nevertheless, construction activities at the projects will have some environmental effects to aquatic resources, including fish. The Trust proposes several measures to minimize these effects, as described below.

Veazie Project

- Provide upstream fish passage during dam removal activities by using the fish ladder until a breach is executed;
- Continue to operate the bypass weir to pass downstream migrating diadromous fish species during interim operations;
- Use standard soil erosion and sediment control measures in conformance with federal and state permitting requirements;
- Maintain a zone of passage throughout project activities and by drawing down of the impoundment in stages;
- Plan the timing of construction activities in consultation with natural resource agencies. This includes continued collection of Atlantic salmon broodstock by state and federal agencies and development of a schedule for maintaining broodstock collection during the dam removal process;
- Provide for effective fish passage by re-grading the channel at the dam, if necessary, and conducting an evaluation of fish passage following dam removal;
- Prevent the establishment of invasive plant species, offset potential unsightliness of the newly exposed shoreline, and control potential erosion along the impoundment perimeter following dam removal by implementing landscape restoration plans, including planting with selected native species, and if warranted, implementing an invasive plant species management and control program for the initial three years after dam removal that incorporates creating temporary and permanent vegetative cover, where necessary;
- Monitor the mouths of tributary streams entering the impoundment following dam removal, and take corrective action if sediment deposits are present that impede the flow of the tributaries into the lowered river elevation; and,
- Reduce generation by turning off 16 of the total 17 units between 8:00 PM and 4:00 AM daily during the dates May 7 – May 20 to protect downstream migrating Atlantic salmon

smolts and kelts.

Howland Project

- Maintain functionality of the existing fish ladder until the flashboards are removed (the flashboards will not be removed until the bypass channel is constructed and operational);
- Continue to operate the bypass weir to pass downstream migrating diadromous fish species during interim operations;
- Provide "safe, timely and effective" passage of diadromous fish species via the new bypass channel;
- Conduct a fish passage evaluation following removal of the Howland Dam flashboards and construction of the nature-like bypass;
- Mitigate for temporary construction-related effects of the fish bypass channel on water quality and aquatic resources through use of standard soil erosion and sediment control measures in conformance with federal and state permitting requirements;
- Prevent the establishment of invasive plant species, offset potential unsightliness of the newly exposed shoreline, and control potential erosion along the impoundment perimeter following flashboard removal by implementing landscape restoration plans, including planting with selected native species, and if warranted, implementing an invasive plant species management and control program for the initial three years after flashboard removal that incorporates creating temporary and permanent vegetative cover, where necessary;
- Avoid effects to diadromous fish species by planning the timing of construction activities in consultation with natural resource agencies; and
- Reduce generation by turning off two of the total three units between 8:00 PM and 4:00 AM daily during the dates May 7 – May 20 to protect downstream migrating Atlantic salmon smolts and kelts.

2.2.3. Post-Removal Actions

Following removal of each dam, the final phase of the project will involve stabilization and close out. Any remaining structures and remnants of structures along the banks and within the newly exposed banks will be removed; banks will be stabilized and planted as necessary; access ways will be removed and restored; and, sediment and erosion controls will be removed. Following removal of the Veazie Project, dam removal and water level draw-downs may necessitate protection and/or modification of existing infrastructure. The Trust anticipates the following additional work: 1) extension of an existing boat launch in Eddington, Maine; 2) placement of stone riprap at existing storm drains, culverts, and other outlets for erosion control; 3) placement of erosion control blanket over sandy-silt deposits for temporary stabilization; and 4) placement of stone riprap at the base of existing walls as a splash pad. These activities required a separate permit from the ACOE under the Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Accordingly, the Trust has secured the necessary state and federal permits for those actions.

At the Howland Project, the existing log sluice will be retrofitted to provide downstream fish passage and attraction flow after completion of bypass channel construction. The bypass itself is also expected to pass a significant number of downstream migrating migratory fish species. The final phase of construction will complete grading and site restoration, upland landscape plantings (including top soiling and seeding of disturbed areas), and removal of erosion controls.

2.3. 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 both the direct and indirect effects of the proposed action would affect listed species and critical habitat. The action area includes the project footprint where the dams will be removed and fishways installed as well as the area of the river where increased underwater noise levels, sediment loads, and changes in water quality will be experienced.

Dam removal and construction activities at the Veazie and Howland Projects is expected to affect much of the Penobscot River watershed which encompasses the range of shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon in the Penobscot River. Short-term, construction related effects are expected to occur largely in the vicinity of the Veazie and Howland Projects. However, long-term beneficial effects of the project are expected to occur throughout the Penobscot River watershed through improved connectivity, increased marine derived nutrient exchange, prey buffering, and improved water quality conditions. Therefore, the entire Penobscot River watershed represents the action area for this consultation (Figure 1).

3. STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

We have determined that the following endangered or threatened species may be affected by the proposed action:

Fish

Gulf of Maine DPS of Atlantic salmon	Endangered
Shortnose sturgeon	Endangered
New York Bight DPS of Atlantic sturgeon	Endangered
Gulf of Maine DPS of Atlantic sturgeon	Threatened

Critical Habitat

Designated for the Gulf of Maine DPS of Atlantic salmon

The status of Atlantic salmon and shortnose sturgeon, as well as Atlantic salmon critical habitat, was addressed in the Opinion we issued in December of 2009. New information has become available since that time, however, and has been incorporated into this section of the Opinion. Since the issuance of the 2009 Opinion, five DPSs of Atlantic sturgeon have been listed as threatened or endangered.

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

3.1. Gulf of Maine DPS of Atlantic Salmon

3.1.1. Species Description

The Atlantic salmon is an anadromous fish species that spends most of its adult life in the ocean but returns to freshwater to reproduce. The Atlantic salmon is native to the North Atlantic Ocean, from the Arctic Circle to Portugal in the eastern Atlantic, from Iceland and southern Greenland, and from the Ungava region of northern Quebec south to the Housatonic River (Bigelow and Schroeder 1953). In the United States, Atlantic salmon historically ranged from Maine south to Long Island Sound. However, the Central New England DPS and Long Island Sound DPS have both been extirpated (65 FR 69459; November 17, 2000).

The GOM DPS of anadromous Atlantic salmon was initially listed jointly by the USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). In 2009 the Services finalized an expanded listing of Atlantic salmon as an endangered species (74 FR 29344; June 19, 2009). The decision to expand the range of the GOM DPS was largely based on the results of a Status Review (Fay *et al.* 2006) completed by a Biological Review Team consisting of Federal and State agencies and Tribal interests. Fay *et al.* (2006) conclude that the DPS delineation in the 2000 listing designation was largely appropriate, except in the case of large rivers that were partially or wholly excluded in the 2000 listing determination. Fay *et al.* (2006) conclude that the salmon currently inhabiting the larger rivers (Androscoggin, Kennebec, and Penobscot) are genetically similar to the rivers included in the GOM DPS as listed in 2000, have similar life history characteristics, and occur in the same zoogeographic region. Further, the salmon populations inhabiting the large and small rivers from the Androscoggin River northward to the Dennys River differ genetically and in important life history characteristics from Atlantic salmon in adjacent portions of Canada (Spidle *et al.* 2003, Fay *et al.* 2006). Thus, Fay *et al.* (2006) conclude that this group of populations (a "distinct population segment") met both the discreteness and significance criteria of the Services' DPS Policy (61 FR 4722; February 7, 1996) and, therefore, recommend the geographic range included in the new expanded GOM DPS.

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

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

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

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

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 fresh water until the following spring before returning to the sea (Fay *et al.* 2006). From 1996 to 2011, approximately 1.3 percent of the “naturally-reared” adults (fish originating from natural spawning or hatchery fry) in the Penobscot River were repeat spawners (USASAC 2012).

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

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

In a parr’s second or third spring (age 1 or age 2, respectively), when it has grown to 12.5 to 15 cm in length, a series of physiological, morphological, and behavioral changes occur (Schaffer and Elson 1975). This process, called “smoltification,” prepares the parr for migration to the ocean and life in salt water. In Maine, the vast majority of naturally reared parr remain in fresh water for two years (90 percent or more) with the balance remaining for either one or three years (USASAC 2005). In order for parr to undergo smoltification, they must reach a critical size of ten centimeters total length at the end of the previous growing season (Hoar 1988). During the smoltification process, parr markings fade and the body becomes streamlined and silvery with a pronounced fork in the tail. Naturally reared smolts in Maine range in size from 13 to 17 cm, and most smolts enter the sea during May to begin their first ocean migration (USASAC 2004).

During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and various predator assemblages. The physiological changes that occur during smoltification prepare the fish for the dramatic change in osmoregulatory needs that come with the transition from a fresh to a salt water habitat (Ruggles 1980, Bley 1987, McCormick and Saunders 1987, McCormick *et al.* 1998). The transition of smolts into seawater is usually gradual as they pass through a zone of fresh and saltwater mixing that typically occurs in a river's estuary. Given that smolts undergo smoltification while they are still in the river, they are pre-adapted to make a direct entry into seawater with minimal acclimation (McCormick *et al.* 1998). This pre-adaptation to seawater is necessary under some circumstances where there is very little transition zone between freshwater and the marine environment.

The spring migration of post-smolts out of the coastal environment is generally rapid, within several tidal cycles, and follows a direct route (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004). Post-smolts generally travel out of coastal systems on the ebb tide and may be delayed by flood tides (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004, Lacroix and Knox 2005). Lacroix and McCurdy (1996), however, found that post-smolts exhibit active, directed swimming in areas with strong tidal currents. Studies in the Bay of Fundy and Passamaquoddy Bay suggest that post-smolts aggregate together and move near the coast in "common corridors" and that post-smolt movement is closely related to surface currents in the bay (Hyvarinen *et al.* 2006, Lacroix and McCurdy 1996, Lacroix *et al.* 2004). European post-smolts tend to use the open ocean for a nursery zone, while North American post-smolts appear to have a more near-shore distribution (Friedland *et al.* 2003). Post-smolt distribution may reflect water temperatures (Reddin and Shearer 1987) or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts live mainly on the surface of the water column and form shoals, possibly of fish from the same river (Shelton *et al.* 1997).
During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56^{o}N. and 58^{o}N. (Reddin 1985, Reddin and Short 1991, Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish or MSW) and also includes immature salmon from both North American and European stocks (Reddin 1988, Reddin *et al.* 1988). The first winter at sea regulates annual recruitment, and the distribution of winter habitat in the Labrador Sea and Denmark Strait may be critical for North American populations (Friedland *et al.* 1993). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985, Dutil and Coutu 1988, Ritter 1989, Reddin and Friedland 1993, and Friedland *et al.* 1999). Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Reddin and Friedland (1993) found immature adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the Labrador and Irminger Sea in the later summer and autumn.

3.1.2 *Status and Trends of Atlantic Salmon in the GOM DPS*

The abundance of Atlantic salmon within the range of the GOM DPS has been generally declining since the 1800s (Fay *et al.* 2006). Data sets tracking adult abundance are not available throughout this entire time period; however, 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 slow population growth between the 1970s and the early 1980s, adult returns of salmon in the GOM DPS peaked between approximately 1984 and 2001 before declining during the 2000s. Adult returns have been increasing again over the last few years. The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH that was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed throughout 1990s and early 2000s. The increase in the abundance of returning adult salmon observed between 2008 and 2011 may be an indication of improving marine survival.

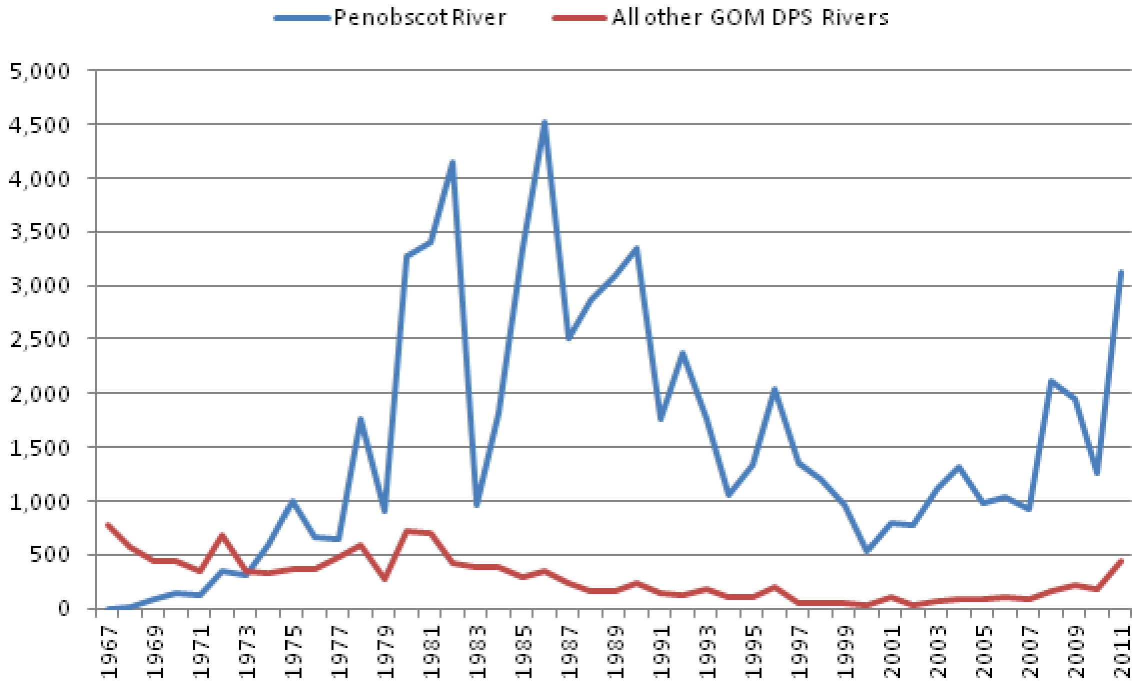

Figure 2. Adult returns to the GOM DPS Rivers between 1967 and 2011(Fay *et al.* 2006, USASAC 2001-2012).

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

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

In conclusion, the abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (approximately 6% over the last ten years) but appears stable. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels. However, stocking of hatchery products has not contributed to an increase in the overall abundance of salmon and as yet has not been able to increase the naturally reared component of the GOM DPS. Continued reliance on the conservation hatchery program could prevent extinction in the short term, but recovery of the GOM DPS must be accomplished through increases in naturally reared salmon.

3.1.3. *Status of Atlantic Salmon in the Action Area*

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section will focus on the status of Atlantic salmon and designated critical habitat in the action area. The Penobscot River watershed supports the largest runs of Atlantic salmon in the GOM DPS. This is due to the large amount of available habitat and large-scale stocking program that includes smolt, parr, fry, and restocking of captured sea-run adults after spawning at the Craig Brook National Fish Hatchery (CBNFH). Roughly 600,000 smolts are stocked in the Penobscot River watershed annually. In addition, over two million fry and parr are stocked in the Penobscot River watershed annually. As such, all lifestages of Atlantic salmon could be present in the action area of this consultation.

Upstream migrating adults

All adults returning to the Penobscot River are collected at the Veazie Dam fishway. Adults captured at the fishway are either taken to CBNFH for captive breeding or returned to the river upstream of the Veazie Dam. Since the initial listing of the GOM DPS of Atlantic salmon in

2000, the number of returning adults (both naturally-reared and conservation hatchery stocked) captured at the fishway trap at the Veazie Dam has ranged from as low as 534 in 2000 to as many as 3,123 in 2011(USASAC 2012). The majority of adult returns to the Penobscot River are of hatchery origin (Fay *et al.* 2006). In 2011, 92% of adult Atlantic salmon returns were of hatchery smolt origin, and the balance (8%) originated from fry stocking or natural reproduction (USASAC 2012).

The Veazie fishway trap is operated each year from May 1 to October 31 (MDMR, MDIFW 2009). The majority of the adult salmon captures at Veazie occur in June, with the median capture date occurring around the last week of June (MDMR 2008). Use of the rubber dam system at the Veazie spillway has led to improved, and earlier captures of adult salmon in the river (MDMR 2007). Although the overall size of the salmon run differs from year to year, the monthly breakdown and median capture dates are similar (Table 1)(MDMR 2007, MDMR 2008, Dube *et al.* 2011).

Table 1. Monthly total and median capture dates of Atlantic salmon collected at the Veazie Trap during 2007-2010.

	2007		**2008**		**2009**		**2010**		
Month	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**Mean Distribution**
May	48	5%	267	13%	173	9%	344	26%	13%
June	458	50%	1465	69%	1382	71%	782	59%	65%
July	268	29%	236	11%	370	19%	141	11%	16%
August	79	9%	111	5%	14	1%	18	1%	4%
September	45	5%	18	1%	11	1%	27	2%	2%
October	18	2%	15	1%	8	0%	4	0%	1%
Total Run	**916**	**100%**	**2112**	**100%**	**1958**	**100%**	**1316**	**100%**	**100%**
Median Capture Date	23-Jun-07		26-Jun-08		18-Jun-09		9-Jun-10		

According to current broodstock management plans, 650 adult salmon are typically collected each year at Veazie Dam for transport to the federal salmon hatcheries in Maine (MDMR 2007). Because of the goal of providing an equal ratio of male and female spawners for hatchery, as well as a proportion of 1-sea winter returns ("grilse"), the goal of 650 spawners is not consistently achieved. Table 2 below presents broodstock targets and number of broodstock collected at the Veazie Dam since 2000.

Table 2. Atlantic salmon broodstock collected at the Veazie Trap during (2000-2011).

Year	**Broodstock Target**	**Total Broodstock Collected**
2000	600	328
2001	600	502
2002	600	377

2003	600	605
2004	600	606
2005	600	475
2006	650	537
2007	650	590
2008	650	650
2009	650	679
2010	650	700
2011	650	739

Adult salmon that are collected at Veazie and not transported to the hatchery for broodstock are put back in the river above the dam and allowed to continue their upstream migration. Although there are fishways at dams above Veazie, including Milford and West Enfield, there are no annual counts of salmon using those fish passage facilities. Studies have shown, however, that upstream migration beyond Veazie proceeds relatively quickly unless dam flashboards are down (which in the case of Great Works makes the fishways inoperable) or water temperature is elevated (Shepard 1995, Gorsky 2005).

Post-spawned adults

Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea, or over-winter in freshwater habitat and migrate in the spring, typically April or May (Baum 1997). Spring flows resulting in spillage at the dams facilitate out-migration of adult salmon (Shepard 1988). Downstream passage success of kelts was assessed as part of radio tag studies conducted for smolts in the Penobscot (GNP 1989, Shepard 1989a, Hall and Shepard 1990). Kelts tended to move downstream early in the spring (mostly mid-April through late May), regardless of whether fish were tagged in the spring or fall (i.e., most radio-tagged study fish generally stayed in the river near where they were placed until the following spring). Because kelt passage occurred during periods of spill at most dams, a large portion of study fish (90%) passed dams via spillage (i.e., over the dam). Kelt attraction to, and use of, downstream passage facilities was highly variable depending on facility, year of study, and hydrological conditions (e.g., spill or not). At the upstream confluences (i.e., the Stillwater Branch and the main stem), kelts followed the routes in approximate proportion to flow in the two channels.

Downstream migrating smolts

Out-migrating Atlantic salmon smolts in the Penobscot River watershed are the result of wild production following natural spawning and juvenile rearing, or from stocking fry, parr, and smolts (Fay *et al.* 2006). The majority of the salmon run on the Penobscot are the result of stocked smolts; current management plans call for stocking 600,000 hatchery reared smolts at various locations in the main stem above Veazie Dam and in the Pleasant River (Piscataquis River sub-drainage) (MDMR, MDIFW 2009). Based on unpublished data from smolt-trapping studies in 2000 – 2005 by NMFS, smolts migrate from the Penobscot between late April and early June. The majority of the smolt migration appears to take place over a three to five week period after water temperatures rise to 10°C.

Rotary screw traps (RSTs) were used by NMFS during 2000-2005 to monitor downstream migrating smolts in the Penobscot River (Figure 3). Traps were deployed 0.87, 1.54, and 1.77 kilometers below the Veazie Dam. During the sampling period, the number of smolts captured in RSTs ranged from 72 to 3,165 annually. RST sampling in the Piscataquis River by MDMR in 2004 and 2005 captured 497 and 315 smolts, respectively. It is not currently possible to estimate the total number (wild and stocked) of smolts emigrating in the Penobscot or Piscataquis River, but the run is certainly related to the number of fish stocked annually.

Atlantic salmon utilize free-flowing rivers and streams for spawning and juvenile rearing. The lake-like condition of the impoundments at the Milford, West Enfield, Medway, Orono and Stillwater Projects do not provide suitable spawning or rearing habitat for Atlantic salmon.

State fishery agencies have estimated juvenile Atlantic salmon production in the Penobscot watershed, using habitat surveys and suitability modeling (MDMR, MDIFW 2009). According to the model, there are 4,070 rearing units (each rearing unit consists of 100 square meters) identified in the reach of the Penobscot River between Milford and West Enfield. However, the state's modeling estimated that the production of salmon parr for this reach was only 388. This is likely due to the fact that parr production is highest in smaller streams in the Penobscot watershed (less than 12 meters wide) and becomes negligible in river segments wider than 100 meters due to factors such as increased water temperatures and biological community composition (MDMR, MDIFW 2009).

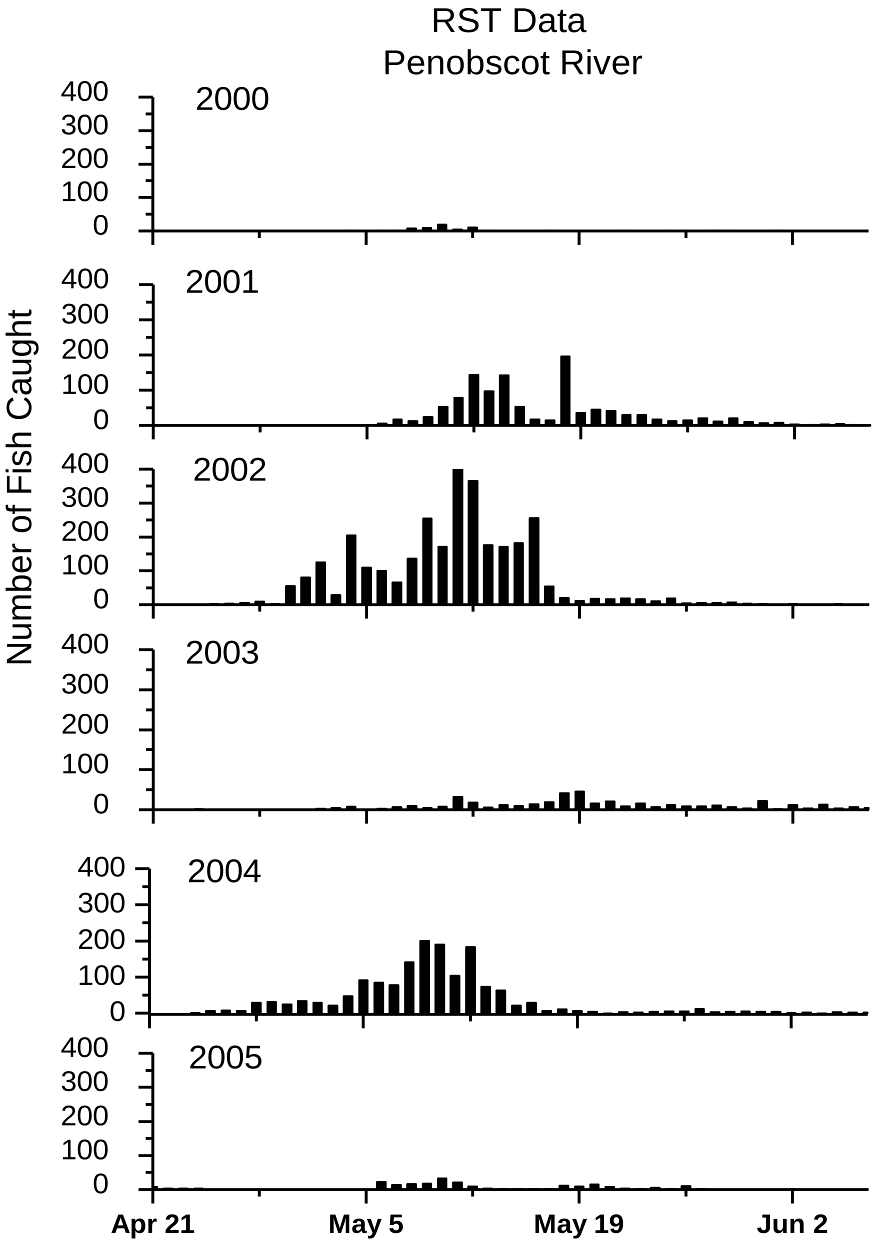

Figure 3. Total number of smolts collected using rotary screw traps in the Penobscot River from 2000 to 2005.

3.1.4. *Factors Affecting Atlantic Salmon in the Action Area*

3.1.4.1.*Hydroelectric Facilities*

The Penobscot River Basin has been extensively developed for hydroelectric power production. There are approximately 116 dams in the Penobscot River watershed; 24 of these dams operate under a FERC hydropower license or exemption (Fay *et al.* 2006). Hydroelectric dams are known to impact Atlantic salmon through habitat alteration, fish passage delays, and entrainment and impingement.

Habitat Alteration

While over 200,000 units of rearing habitat remains accessible in the Penobscot River watershed, historical and present day dams have eliminated or degraded vast, but to date unquantified, reaches of suitable rearing habitat. FERC (1997) estimated that 27% (19 miles) of main stem habitat (i.e., not including the Stillwater Branch segment) is impounded by the five dams between head-of-tide and the confluence of the East and West Branches in Medway. On the West Branch, approximately 57% of the 98 river miles is impounded (USACOE 1990). Approximately 11% of the approximately 74 miles of the Piscataquis River main stem, 28% of the approximately 43 miles of the Sebec River tributary to the Piscataquis, and 8% of the approximately 25 miles of the Passadumkeag River (below natural barrier at Grand Falls) is impounded (USACOE 1990).

Impoundments created by these dams limit access to habitat, alter habitat, and degrade water quality through increased temperatures and lowered dissolved oxygen levels. Furthermore, because hydropower dams are typically constructed in reaches with moderate to high underlying gradients, approximately 50% of available gradient in the main stem, and 41% in the West Branch, is impounded (USACOE 1990, FERC 1997). Coincidently, these moderate to high gradient reaches, if free-flowing, would likely constitute the highest value as Atlantic salmon spawning, nursery, and adult resting habitat within the context of all potential salmon habitat within these reaches.

Compared to a natural hydrograph, the operation of dams in a store-and-release mode on the East Branch, and especially on the West Branch of the Penobscot River, results in reduced spring runoff flows, less severe flood events, and augmented summer and early fall flows. Such operations in turn reduce sediment flushing and transport and physical scouring of substrates, and increase surface area and volume of summer and early fall habitat in the main stem. Water drawn from impoundments in the West Branch often constitutes half or more of the streamflow in the main stem during the otherwise drier summer months (data analyzed from FERC 1996).

The extent to which these streamflow modifications in the upper Penobscot watershed impact salmon populations, habitat (including migratory corridors during applicable seasons), and restoration efforts is unknown. However, increased embeddedness of spawning and invertebrate colonization substrates, diminished flows during smolt and kelt outmigration, and enhanced habitat quantity and, potentially, “quality” for non-native predators such as smallmouth bass, are likely among the adverse impacts to salmon. Conversely, higher summer and early fall stream flows may provide some benefits to Atlantic salmon or their habitat within affected reaches, and may also help mitigate certain potential water quality impacts (e.g., dilution of harmful industrial and municipal discharges).

Habitat Connectivity

Pre-spawn adults

Among rivers within the range of the GOM DPS with hydropower dams that have one or more formal passage facility, most of the current understanding of fish passage efficiency comes from studies on the Penobscot River. Radio telemetry and other tracking studies by the MDMR and various hydropower project licensees have shown wide variation in site-specific upstream passage success, depending on the dam location and the environmental conditions (e.g., temperature, hydrology) during the year of study. For example, at the Veazie Dam, the percentage of radio tagged Atlantic salmon adults using the fishway ranged from 44% in 1990 to 89% in 1992, and averaged 68% over five years of study in the late 1980s and early 1990s (Dube 1988, Shepard 1989b, Shepard and Hall 1991, Shepard 1995). Shepard (1995) found that water temperatures above 23 C inhibited upstream movements, and that salmon did not hold in low velocity reaches such as impoundments or enter tributaries during periods of low flow. Shepard (1995) also found that spillage delayed passage at dams lacking fishway entrances at the spillway, and that salmon stocked as smolts frequently did not migrate upstream of their stocking location.

MDMR (formerly the Maine Atlantic Salmon Commission (MASC)) tagged several hundred Atlantic salmon adults captured at the Veazie Dam fishway trap with Passive Integrated Transponder (PIT) tags from 2002 to 2004. This study monitored the date and time of passage with tag detectors located at the entrance and exit of the upstream fishway(s) at five main stem and five major tributary hydropower dams in the Penobscot watershed (Beland and Gorsky 2004, MASC unpublished data). Of the 379 total salmon tagged at Veazie in 2002, only 21% (78 fish) also passed the Mattaceunk Project fishway on the main stem, some 50 miles and four additional dams upstream. Less than 1% (3 fish) passed above the Guilford Dam on the Piscataquis River tributary, which is six additional dams upstream. The percentages in 2003 were 9% (41 of 461) and less than 1% (1 of 461) for Mattaceunk and Guilford Dam passages, respectively. In 2004, 19% (142) of the 709 PIT tagged salmon passed Mattaceunk and less that 1% (6) passed Guilford Dam. Many factors affect these results; the most important factor is homing motivation. As many of the study fish were hatchery smolts stocked below Mattaceunk or Guilford Dams, these fish would not be expected to pass the most upstream dams. Nevertheless, proportions of adults reaching two key upriver spawning reaches (East Branch Penobscot River and Piscataquis River above Guilford) are less than would be expected based on the proportion of available production habitat and numbers of fry stocked in those reaches.

At Veazie Dam, upstream passage success ranged from 44% in 1990 to 89% in 1992, with a pooled passage rate 68% (63 of 93) over five years of study using Carlin and radio tags (Shepard 1995). Similarly, a three year study that was conducted between 2002 and 2004 that looked at migratory movements of adult Atlantic salmon using PIT tags indicated passage success at Veazie ranging between 70% and 100% (Beland and Gorsky 2004, MASC unpublished data). In 2005 and 2006, Holbrook *et al.* (2009) conducted acoustic telemetry studies to assess upstream passage of adult salmon in the Penobscot River from the Veazie Dam upstream to the Howland and West Enfield Dams. Passage at Veazie was 50% in 2005 (2 of 4) and 43% in 2006 (3 of 7). Based on all of these studies, Holbrook *et al.* (2009) calculated that passage at the Veazie Project ranged between 43% and 100%, with a median passage rate of 64%.

Upstream passage efficiency ranged between 85% and 100% over four years of study at the West Enfield and Howland Projects, 20 miles upriver from Milford. Based upon radio telemetry studies conducted from 1989-1992, Shepard (1995) estimated pooled upstream passage rates for adult Atlantic salmon at the Howland and West Enfield at 88% for fish released below the Milford Dam and 89% for fish released above the dam. The pooled result for fish released above and below the Milford Dam over those years was 89% (41 out of 46). As part of a PIT tag study in 2002, Beland and Gorsky (2003) determined that 94% (290 of 308) of the Atlantic salmon that passed the Milford Project successfully passed either the Howland or West Enfield Projects. Of the fish that passed the Milford Project in the study conducted by Holbrook *et al.* (2009), 100% (3 of 3 in 2005; 2 of 2 in 2006) continued upriver and passed either the West Enfield or Howland Projects. It is difficult to assess passage rates at the West Enfield Project and the Howland Project separately, as passage at these dams is strongly influenced by the homing behavior of the migrating fish. As such, many of the salmon that pass upstream of the Milford Project are homing to the Piscataquis River and are not motivated to pass the West Enfield Project in the mainstem.

Migratory Delay

Early migration is an adaptive trait that ensures adult Atlantic salmon have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Gorsky (2005) found that migration in Atlantic salmon was significantly affected by flow and temperature conditions in the Penobscot River. He found that high flow led to a decrease in the rate of migration and that rates increased with temperature up to a point (around 23 degrees 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 Veazie Dam in May and June. According to USGS temperature data from Eddington, Maine, the 12-year median daily temperature in the Penobscot River exceeds 23 C in the first week of July.

To access high quality summer holding areas close to spawning areas in the Penobscot River watershed, Atlantic salmon must migrate past multiple dams. Delay at these dams can, individually and cumulatively, affect an individual's ability to access suitable spawning habitat within the narrow window when conditions in the river are suitable for migration. In addition, delays in migration can cause over-ripening of eggs, 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 of these dams would significantly affect a migrant's ability to access suitable spawning habitat, as it would be different for each individual, and would vary from year to year depending on environmental conditions. We believe that 48 hours provide adequate opportunity for pre-spawn adult Atlantic salmon to locate and utilize well-designed upstream fishways at hydroelectric dams.

Available empirical data indicate a wide range in time needed for individual adult salmon to pass upstream of various dams in the Penobscot River once detected in the vicinity of a spillway or tailrace. The yearly pooled median passage time for adults at Veazie Dam ranged from 4.7 days to 33.2 days over five years of study, while the total range of individual passage times over this study period was 0.5 days to 99.5 days (Shepard 1995). The yearly pooled median passage time for adults at the West Enfield or Howland Dam ranged from 1.1 days to 3.1 days over four years of study, while the total range of individual passage times over this study period was 0.9 days to 61.1 days (Shepard 1995).

Outmigrating smolts

Smolts from the upper Penobscot River have to navigate through several dams on their migrations to the estuary every spring. Holbrook *et al.* (2011) found that migrating smolts split when encountering Orson and Marsh Islands, with >74% of smolts staying in the mainstem, and the remainder migrating through the Stillwater Branch. Hatchery smolts were found to use the Stillwater Branch less than wild smolts. In 2005, 14% of hatchery smolts and 26% of wild smolts chose to migrate through the Stillwater Branch. Based on Holbrook's data, NMFS's Northeast Fisheries Science Center (NEFSC) calculated median smolt usage of the Stillwater Branch as 19.7% (NMFS 2012). Smolts in the mainstem currently must navigate through the Milford, Great Works and Veazie Dams, while those in the Stillwater must navigate the Stillwater and Orono Dams. Multiple dam passage studies of smolts in the Penobscot River were conducted in 1989 and 1990. In 1989, net smolt survival past the three lower river mainstem dams (Milford, Great Works, Veazie) and the intervening habitat was between 30.5% and 61% (Shepard 1991). The wide range in these figures reflects the uncertainty as to how to classify tagged smolts that are detected at one or more upstream detection arrays, but then are not detected at the lowermost array at the last dam, where gaps in detection coverage were reported. In 1990, the net smolt survival past four dams (West Enfield, Milford, Great Works and Veazie for those choosing the mainstem route, or West Enfield, Stillwater, Orono, and Veazie for those choosing the Stillwater Branch route) and the intervening habitat was between 38% and 92% (Shepard 1991), again depending on the manner in which undetected fish were treated along the course of the study reach. It should be noted that Shepard studies in 1989 and 1990 were not designed to determine smolt mortality specifically due to turbine passage. Since the Great Works dam is now removed, we expect survival of smolts to be improved in this reach of river.

Smolt studies conducted by Holbrook (2007) documented significant losses of smolts in the vicinity of mainstem dams in the Penobscot River. Of the 355 radio tagged smolts released in 2005, 43% were lost in the vicinity of the West Enfield, Howland, and Milford Dams. In 2006, 60% of tagged smolts (n=291) were lost in the vicinity of the West Enfield, Howland, and Milford Dams. Although these data do not definitively reveal sources of mortality, these losses are likely attributable to the direct and indirect effects of the dams (e.g., physical injury, predation).

Very few studies have been conducted in Maine to directly assess fish entrainment and mortality on Atlantic salmon at hydroelectric facilities. In the only known study addressing turbine-passage mortality at a Penobscot River hydropower dam, Shepard (1993) estimated acute mortality of hatchery smolts passing through the two horizontal Kaplan turbines at the West Enfield Dam at 2.3% (n = approximately 410). Delayed mortality of the control group (smolts exposed to similar conditions except turbine passage) was quite high ranging from 20% in 1993 to 40% in 1992. Delayed mortality of turbine-passed smolts was considerably higher, ranging from 42% in 1993 to 77% in 1992. The high observed delayed mortality in the control group lead Shepard (1993) to conclude that any comparisons of delayed mortality between the control and treatment would be unreliable.

Studies conducted by NMFS in 2003 reported a much higher rate of dead smolts in the Penobscot smolt traps (5.2%) compared to parallel studies on the Narraguagus (0.3%) where there are no operating hydroelectric dams (USASAC 2004). Although some of this difference could be due to the fact that most of the smolts in the Penobscot study were hatchery origin while all of the Narraguagus smolts were wild or naturally reared, the nature of injuries observed for the 22 Penobscot smolt mortalities indicated that more than 60% were the result of entrainment (USASAC 2004). Injuries attributed to turbine entrainment were also noted on smolts collected alive during the studies.

The route that a salmon smolt takes when passing a project is a major factor in its likelihood of survival. Fish that pass through a properly designed downstream bypass have a better chance of survival than a fish that goes over a spillway, which, in turn, has a better chance of survival than a fish swimming through the turbines. It can be assumed that close to 100% of smolts will survive when passing through a properly designed downstream bypass. However, based on the results of field trials looking at fish passage over spillways at five hydroelectric dams, only 97.1% of smolts are likely to survive passage via spillage (Normandeau Associates, Inc. 2011). Survival through turbines varies significantly based on numerous factors, but as described above can be significantly lower than the other two routes. A smolt study was conducted for Black Bear in 2010 to assess passage efficiency of the downstream bypass at the Orono Dam on the Stillwater Branch (Aquatic Science Associates, Inc. 2011). Radio and PIT tagged hatchery smolts were released under spill and non-spill conditions. Under spill conditions 13% of the smolts used the bypass, 17% went through the turbines, and 69% passed via spillage. Under non-spill conditions, 42% of smolts used the bypass and 58% went through the turbines.

Alden Research Laboratory, Inc. (Alden Lab 2012) has modeled current smolt survival rates at 15 dams on the Penobscot River, based on turbine entrainment, spill mortality estimates and bypass efficiency. Alden Lab conducted a literature review to estimate survival rates based on passage route. Based on that review, it was estimated that mortality through a properly designed bypass would not exceed 1%, whereas mortality via spillage would not exceed 3%. The estimates of mortality due to passage through the turbines was calculated based on the characteristics of individual turbines (such as type of turbine, number of blades and the speed of rotation) and were therefore project specific. In addition to these route-specific estimates, Alden Lab estimated a 5% indirect mortality rate (due primarily to predation and sublethal injuries during passage), regardless of passage route (Alden Lab 2012). Using these assumptions, Alden Lab estimated that the mean survival rates of all 15 dams ranged between 86% and 92% (Table 3).

Table 3. Modeled smolt survival rates under current conditions at May flows for 15 dams on the Penobscot River (Alden Lab 2012) .

Project	Mean	Min	Max
Veazie	89.7%	82.7%	91.3%
Great Works	86.1%	77.7%	89.6%

Milford	91.6%	75.6%	92.0%
West Enfield	92.5%	92.3%	93.6%
Mattaceunk	86.0%	77.2%	89.8%
Orono	90.1%	81.6%	91.5%
Stillwater	91.9%	90.5%	92.1%
Medway	91.2%	88.4%	91.9%
Howland	91.5%	89.6%	92.7%
Brown's Mill	86.5%	61.5%	91.8%
Lowell Tann.	88.7%	84.7%	94.9%
Moosehead	87.9%	66.0%	91.0%
Milo	89.0%	85.2%	90.9%
Sebec	88.7%	83.4%	90.9%
Frankfort	92.0%	90.8%	94.4%

The potential for delays in the timely passage of smolts encountering hydropower dams is also evident in some tracking studies. At the Mattaceunk Dam, the average time needed for hatchery smolts to pass the dam, after being detected in the forebay area, was 15.6 hours (range 0 to 72 hours), 39.2 hours (range 0 to 161 hours), 14.6 hours (range 0 to 59.4 hours) and 30 hours (range 0.2 to 226 hours) in four different study years (GNP 1995, GNP 1997, GNP 1998, GNP 1999). At the West Enfield Dam, the median delay was 0.86 hours (range 0.3 to 49.7 hours) for hatchery smolts in 1993 (BPHA 1993), and approximately 13 hours (range 0.2 to 102.9 hours) for wild smolts in 1994 (BPHA 1994). At the Orono Dam, the median delay between release and passage of smolts was 3.4 hours (range 0.6 to 33.3 hours) in 2010 (Aquatic Science Associates, Inc 2011). While these delays can lead to direct mortality of Atlantic salmon from increased predation (Blackwell *et al.* 1998), migratory delays can also reduce overall physiological health or physiological preparedness for seawater entry and oceanic migration (Budy *et al.* 2002). Various researchers have identified a “smolt window” or period of time in which smolts must reach estuarine waters or suffer irreversible effects (McCormick *et al.* 1999). Late migrants lose physiological smolt characteristics due to high water temperatures during spring migration (McCormick *et al.* 1999). Similarly, artificially induced delays in migration from dams can result in a progressive misalignment of physiological adaptation of smolts to seawater entry, smolt migration rates, and suitable environmental conditions and cues for migration. If so, then these delays may reduce smolt survival (McCormick *et al.* 1999).

Outmigrating kelts

Atlantic salmon kelts move downstream after spawning in November or, alternatively, overwinter in freshwater and outmigrate early in the spring (mostly mid-April through late May). Lévesque *et al.* (1985) and Baum (1997) suggest that 80% of kelts overwinter in freshwater habitat prior to returning to the ocean. Downstream passage success of kelts has been assessed in the Penobscot (GNP 1989, Shepard 1989a, Hall and Shepard 1990). Kelt passage occurred during periods of spill at most dams, and a large portion of study fish used the spillage. Success over mainstem Penobscot River dams was usually greater than 90% at any one site. Kelt attraction to, and use of, downstream passage facilities was highly variable depending on facility, year of study, and hydrological conditions (e.g., spill or not). At the upstream confluences (i.e., the Stillwater Branch and the mainstem), kelts followed the routes in approximate proportion to flow in the two channels (approximately 40%/60%). Shepard (1989a) documented that kelts relied on spillage flows to migrate past the Milford and Veazie Dams during a study conducted in 1988. In fact, some kelts spent hours to days searching for spillway flows to complete their downstream migration during the 1988 study.

Alden Lab (2012) has modeled the current survival rates of kelts at the dams on the Penobscot River, based on turbine entrainment, spill mortality estimates and bypass efficiency (Table 4). Alden Lab's analysis accounted for both immediate and delayed mortality associated with dam passage. Through the three months of outmigration, Alden Lab indicates that mean survival rates at 15 of the dams on the Penobscot range between 31% and 93%.

Table 4. Modeled kelt survival rates under current conditions at May flows for hydroelectric projects on the Penobscot River (Alden Lab 2012).

Project	**April**			**May**			**November**		
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Veazie	85.0%	80.6%	87.5%	80.8%	71.8%	86.1%	84.5%	71.8%	89.2%
Great Works	92.9%	92.5%	94.1%	93.0%	92.5%	94.1%	93.3%	92.6%	94.1%
Milford	86.2%	69.3%	89.3%	84.7%	69.3%	89.5%	81.8%	65.8%	88.4%
West Enfield	91.0%	90.2%	91.6%	91.0%	90.2%	91.6%	90.8%	90.2%	94.1%
Mattaceunk	82.7%	75.8%	87.7%	85.2%	75.8%	89.5%	85.0%	75.8%	89.5%
Orono	87.9%	81.2%	90.1%	86.6%	65.8%	90.2%	83.6%	65.8%	89.4%
Stillwater	88.0%	65.8%	90.2%	85.7%	65.8%	90.3%	82.5%	65.8%	89.5%
Medway	31.0%	0.0%	60.0%	67.8%	0.0%	84.2%	66.6%	47.0%	79.8%
Howland	92.6%	92.3%	94.1%	92.8%	92.3%	94.1%	92.9%	92.4%	94.1%
Brown's Mill	92.7%	92.4%	94.1%	92.9%	92.4%	94.1%	93.1%	92.4%	94.1%
Lowell Tannery	82.8%	74.9%	94.5%	83.3%	74.9%	94.5%	81.2%	47.0%	94.5%
Moosehead	92.2%	92.2%	92.2%	82.3%	0.0%	92.2%	76.3%	0.0%	92.2%
Milo	64.5%	43.6%	82.0%	66.8%	43.6%	83.2%	61.6%	0.0%	89.5%
Sebec	89.7%	86.0%	94.1%	89.8%	86.0%	92.3%	89.7%	86.0%	94.1%
Frankfort	68.4%	53.5%	90.8%	70.9%	53.5%	94.1%	71.6%	53.5%	94.1%

Delayed Effects of Downstream Passage

In addition to direct mortality sustained by Atlantic salmon at hydroelectric projects, Atlantic salmon in the Penobscot River will also sustain delayed mortality as a result of repeated passage events at multiple hydroelectric projects. 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 hydro 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 hydropower 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 (i.e., turbines, spillways, bypass and transport systems).

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 hydrosystem 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 damless 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.

Given the difficulty in estimating this type of mortality at the present time, we do not have sufficient data to specifically assess the effect of hydrosystem-related mortality in the Penobscot River. Thus, we have not attempted to quantify the delayed (or delayed) loss of smolts or kelts attributed to Black Bear's projects in this Opinion. Nevertheless, considering that there are presently 14 FERC licensed hydroelectric projects in the Penobscot River watershed, it can be assumed that practically all smolts and kelts in the river must pass at least two hydroelectric dams during the downstream migrations and the resulting loss of endangered Atlantic salmon could be significant. According to a model developed by NMFS (2012; Figure 4), even a small cumulative mortality rate (1-10%) could have a significant effect on the number of returning 2 SW female Atlantic salmon in the Penobscot River watershed. It should be noted, however, that removal of the Veazie and Great Works Projects and decommissioning the Howland Project should significantly reduce the hydrosystem-related mortality of smolts and kelts in the river.

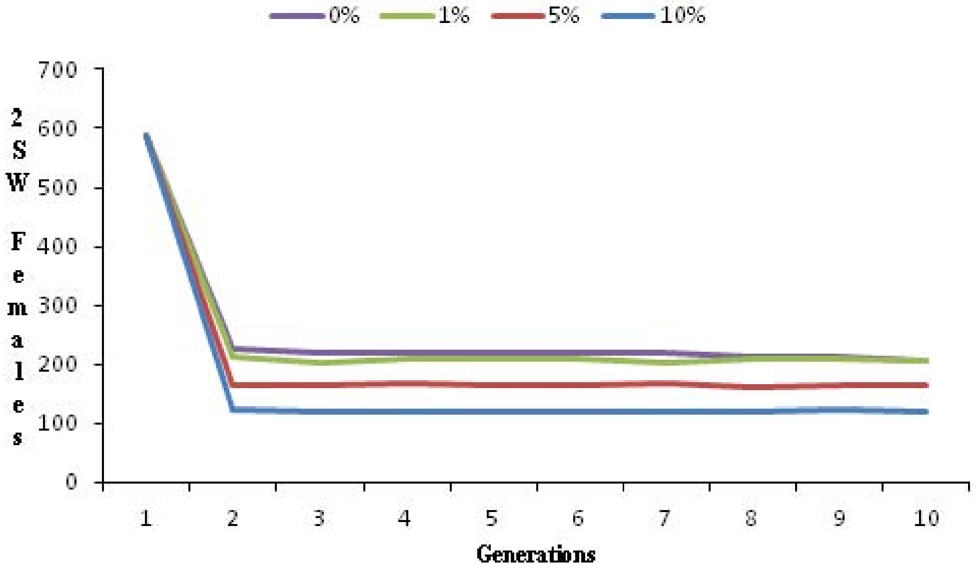

Figure 4. The potential effects of cumulative delayed mortality on the abundance of returning 2SW female Atlantic salmon over ten generations (NMFS 2012).

3.1.4.2. Predation

In addition to direct mortality during downstream passage, kelts and smolts are exposed to indirect mortality caused by sub-lethal injuries, increased stress, and/or disorientation. A large proportion of indirect mortality is a result of disorientation caused by downstream passage, which can lead to elevated levels of predation immediately downstream of the project (Mesa 1994).

Predation upon Penobscot River smolts has been studied by Blackwell (1996), as it relates to double crested cormorants, and by Van den Ende (1993) for certain fish species. In addition, the Penobscot River smolt migration studies described above have documented high smolt loss rates throughout the river system including free-flowing sections which implicate these same predators.

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 are very abundant in the Penobscot River—smallmouth bass inhabit the entire main stem migratory corridor as well as many of the juvenile Atlantic salmon rearing habitats such as the East Branch Penobscot River and the Piscataquis River. 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 smolts within the range of the GOM DPS and certainly feed upon fry and parr, as well as smolts, given their piscivorous feeding habits (Van den Ende 1993). 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 Pushaw Lake which drains to the Lower Penobscot River (Fay *et al.* 2006). Northern pike have expanded their range in the Penobscot River to include the Pushaw Stream outlet, nearby Mud Pond and probably portions of the main stem Penobscot River, since there are no barriers to their movement. Northern pike are ambush predators that rely on vision and thus, predation upon smolts occurs primarily in daylight with the highest predation rates in low light conditions at dawn and dusk (Bakshtansky *et al.*1982). Hatchery smolts experience higher rates of predation by fish than wild smolts, particularly from northern pike (Ruggles 1980, Bakshtansky *et al.* 1982).

Many species of birds prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell *et al.* (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at main stem dam foraging sites. Cormorants were present in the Penobscot River during the spring smolt migration as migrants, stopping to feed before resuming northward migrations, and as resident nesting birds using Penobscot Bay nesting islands (Blackwell 1996, Blackwell and Krohn 1997). The abundance of alternative prey resources such as upstream migrating alewife, likely minimizes the impacts of cormorant predation on the GOM DPS (Fay *et al.* 2006). Common mergansers and belted kingfishers are likely the most important predators of Atlantic salmon fry and parr in freshwater environments.

3.1.4.3. 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), a type of waste water treatment system), and industrial sites and discharges. The Maine Department of Environmental Protection (DEP) issues permits under the National Pollutant Discharge Elimination System (NPDES) for licensed point source discharges. Conditions and license limits are set to maintain the existing water quality classification. Generally, the impacts of point source pollution are greater in the larger rivers of the GOM DPS. The DEP has a schedule for preparing a number of TMDLs for rivers and streams within the Penobscot River watersheds. TMDLs allocate a waste load for a particular pollutant for impaired waterbodies. The main stem of the Penobscot River from its confluence with the Mattawamkeag River to Reeds Brook in Hampden has restricted fish consumption due to the presence of dioxin from industrial point sources. Combined sewer overflows from Milford, Old Town, Orono, Bangor, and Brewer produce elevated bacteria levels, thus inhibiting recreation uses of the river (primary contact). The lower area of the river south of Hampden to Verona Island is impaired due to contamination of mercury, PCBs, dioxin, and bacteria from industrial and municipal point sources. The West Branch of the Penobscot River is impaired due to hydro development and water withdrawals, thus creating aquatic life issues. Color inducing discharges in the West Branch of the Penobscot River are affecting water quality in the Penobscot River. Many small tributaries on the lower river in the Bangor area have aquatic life problems due to bacteria from both NPS and urban point sources. Parts of the Piscataquis River and its tributaries are impaired from combined sewer overflows and dissolved oxygen issues from agricultural NPS and municipal point sources. Approximately 160 miles of the Penobscot River and its tributaries are listed as impaired by the DEP.

3.1.5. 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. 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 Services are writing a new recovery plan that will include the current, expanded GOM DPS and its designated critical habitat. The new recovery plan provides the most up to date list of significant threats affecting the GOM DPS. These are the following:

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

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

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

Fay *et al.* (2006) examined each of the five statutory ESA listing factors and determined that each of the five listing factors is at least partly responsible for the present low abundance of the GOM DPS. The information presented in Fay *et al.* (2006) is reflected in and supplemented by the final listing rule for the new GOM DPS (NMFS and USFWS 2009). The following gives a brief overview of the five listing factors as related to the GOM DPS.

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

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

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

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

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

Efforts to Protect the GOM DPS of Atlantic salmon

Efforts aimed at protecting Atlantic salmon and their habitats in Maine have been underway for well over one hundred years. These efforts are supported by a number of federal, state, and local government agencies, as well as many private conservation organizations. The 2005 recovery plan for the originally-listed GOM DPS (NMFS and USFWS 2005) presented a strategy for recovering Atlantic salmon that focused on reducing the most severe threats to the species and immediately halting the decline of the species to prevent extinction. The 2005 recovery program included the following elements:

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

A wide variety of activities have focused on protecting Atlantic salmon and restoring the GOM DPS, including (but not limited to) hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to

Atlantic salmon and developing effective restoration strategies. In light of the 2009 GOM DPS listing and designation of critical habitat, the Services are producing a new recovery plan for the expanded GOM DPS of Atlantic salmon.

3.2. Critical Habitat for Atlantic Salmon in the GOM DPS

Coincident with the June 19, 2009 endangered listing, NMFS designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009) (Figure 5). 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).

Primary Constituent Elements of Atlantic Salmon Critical Habitat

Designation of critical habitat is focused on the known primary constituent elements (PCEs), within the occupied areas of a listed species that are deemed essential to the conservation of the species. Within the GOM DPS, the PCEs for Atlantic salmon are: 1) sites for spawning and rearing, and 2) sites for migration (excluding marine migration[1]). NMFS 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 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.

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

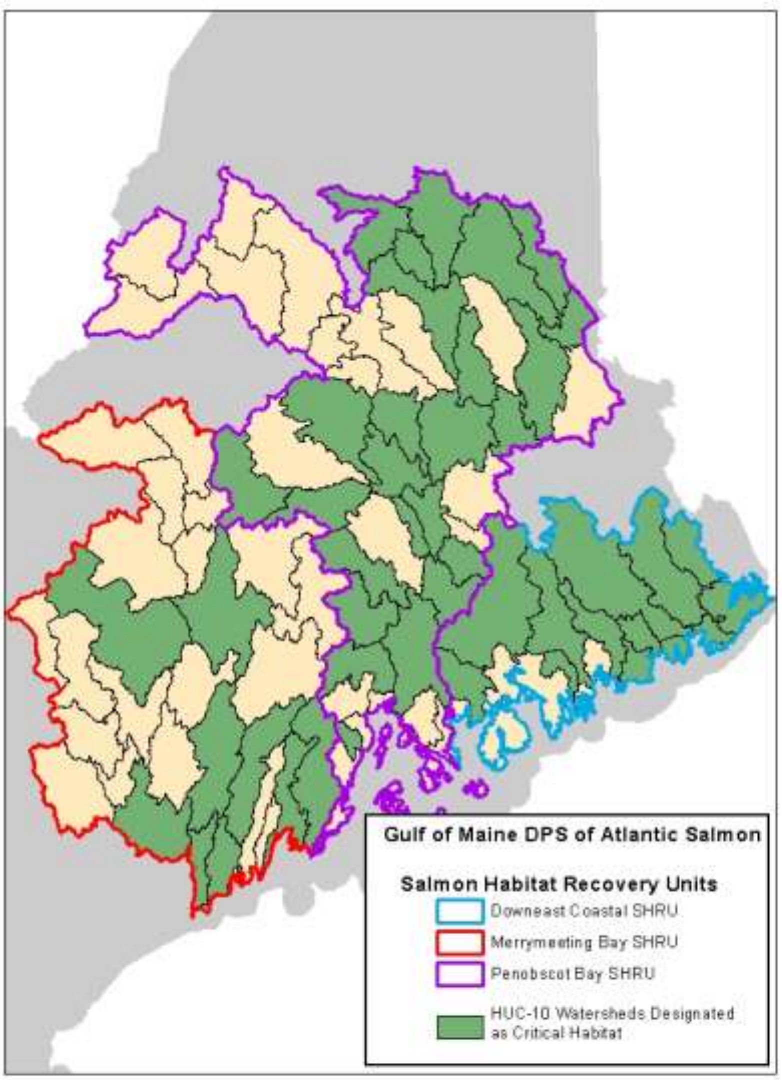

Figure 5. HUC-10 Watersheds Designated as Atlantic salmon Critical Habitat within the GOM DPS.

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.

<u>Physical and Biological Features of the Migration PCE</u>

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

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

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

Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

In describing critical habitat for the GOM DPS, NMFS 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 by NMFS 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, NMFS determined that there were sufficient habitat units available within the currently occupied habitat to achieve recovery objectives in the future; therefore, no unoccupied habitat (at the HUC-10 watershed scale) was designated as critical habitat. A brief historical description for each SHRU, as well as contemporary critical habitat designations and special management considerations, are provided below.

Downeast Coastal SHRU

The Downeast Coastal SHRU encompasses 14 HUC-10 watersheds covering approximately 747,737 hectares (1,847,698 acres) within Washington and Hancock counties. In this SHRU there are approximately 59,066 units of spawning and rearing habitat for Atlantic salmon among approximately 6,039 km of rivers, lakes and streams. Of the 59,066 units of spawning and rearing habitat, approximately 53,400 units of habitat in eleven HUC-10 watersheds are considered to be currently occupied. The Downeast SHRU has enough habitat units available within the occupied range that, in a restored state (*e.g.* improved fish passage or improved habitat quality), the Downeast SHRU could satisfy recovery objectives as described in the final rule for critical habitat (74 FR 29300; June 19, 2009). Certain tribal and military lands within the Downeast Coastal SHRU are excluded from critical habitat designation.

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 km of historically accessible rivers, lakes and streams. Of the 339,182 units of spawning and rearing habitat, approximately 136,000 units of habitat are considered to be currently occupied. There are forty-five HUC-10 watersheds in this SHRU, but only nine are considered currently occupied. Lands controlled by the Department of Defense within the Little Androscoggin HUC-10 and the Sandy River HUC-10 are excluded as critical habitat.

In conclusion, the June 19, 2009 final critical habitat designation for the GOM DPS (as revised on August 10, 2009) includes 45 specific areas occupied by Atlantic salmon that comprise approximately 19,571 km of perennial river, stream, and estuary habitat and 799 km^2 of lake habitat within the range of the GOM DPS and on which are found those physical and biological features essential to the conservation of the species. Within the occupied range of the GOM DPS, approximately 1,256 km of river, stream, and estuary habitat and 100 km^{2}of lake habitat have been excluded from critical habitat pursuant to section 4(b)(2) of the ESA.

3.2.1. Status of Atlantic Salmon Critical Habitat in the Action Area

The environmental baseline of this Opinion describes the status of salmonid habitat, which is important for two reasons: a) because it affects the viability of the listed species within the action area at the time of the consultation; and b) because those habitat areas designated "critical" provide PCEs essential for the conservation (i.e., recovery) of the species. The environmental baseline also describes the status of critical habitat over the duration of the proposed action because it includes the persistent effects of past actions and the future effects of Federal actions that have not taken place but have already undergone section 7 consultation.

The complex life cycles exhibited by Atlantic salmon give rise to complex habitat needs, particularly during the freshwater phase (Fay *et al.* 2006). Spawning gravels must be a certain size and free of sediment to allow successful incubation of the eggs. Eggs also require cool, clean, and well-oxygenated waters for proper development. Juveniles need abundant food sources, including insects, crustaceans, and other small fish. They need places to hide from predators (mostly birds and bigger fish), such as under logs, root wads, and boulders in the stream, as well as beneath overhanging vegetation. They also need places to seek refuge from periodic high flows (side channels and off-channel areas) and from warm summer water temperatures (coldwater springs and deep pools). Returning adults generally do not feed in fresh water but instead rely on limited energy stores to migrate, mature, and spawn. Like juveniles, they also require cool water and places to rest and hide from predators. During all life stages, Atlantic salmon require cool water that is free of contaminants. They also need migratory corridors with adequate passage conditions (timing, water quality, and water quantity) to allow access to the various habitats required to complete their life cycle.

As discussed previously, critical habitat for Atlantic salmon has been designated in the Penobscot River. Both PCEs for Atlantic salmon (sites for spawning and rearing and sites for migration) are present in the action area as it was described in Section 2.3 of this Opinion (the entirety of the Penobscot River watershed). PCEs consist of the physical and biological elements identified as essential to the conservation of the species in the documents designating critical habitat. These PCEs include sites essential to support one or more life stages of Atlantic salmon (sites for spawning, rearing, and migration) and contain physical or biological features essential to the conservation of the species, for example, spawning gravels, water quality and quantity, unobstructed passage, and forage.

To facilitate and standardize determinations of effect for section 7 consultations involving Atlantic salmon critical habitat, we developed the "Matrix of PCEs and Essential Features for Designated Atlantic Salmon Critical Habitat in the GOM DPS" (Table 5). 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 two 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. Using this matrix along with information presented in FERC's BA and site-specific knowledge of each project, NMFS determined that several essential features to Atlantic salmon in the action area have limited function or are not properly functioning currently (Table 6).

Table 5. 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^{o} to 10^{o}C	often between 7^{o} to 10^{o}C	always < 7^{o} or > 10^{o}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^{o}C and 7.2^{o}C, averages nearly 6oC from fertilization to eye pigmentation	averages < 4oC, or 8 to 10^{o}C from fertilization to eye pigmentation	>10^{o}C from fertilization to eye pigmentation
	D.O.	at saturation	7-8 mg/L	< 7 mg/L
	pH	> 6.0	6 - 4.5	< 4.5
	Depth	5.3-15cm	NA	<5.3 or >15cm
	Velocity	4 – 15cm/sec.	NA	<4 or > 15cm/sec.
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

TABLE 5 continued…

		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^{o} to 19^{o}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

TABLE 5 continued…

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

Table 6. Current conditions of essential features of Atlantic salmon critical habitat having limited function or not properly functioning as part of the environmental baseline of the action area.

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	Impoundments degrade spawning and rearing habitat, increase predation, limit productivity, and delay migrations.	Adult abundance and productivity Juvenile growth rate
Water Quality	Adult, juvenile, incubating eggs	Freshwater spawning and rearing	Impoundments degrade spawning and rearing habitat.	Adult abundance and productivity Juvenile growth rate

3.2.2. Factors affecting Atlantic Salmon Critical Habitat in the Action Area

In Section 3.1.4, we present the factors affecting the GOM DPS of Atlantic salmon with the Penobscot River watershed. To the extent that these same factors (hydroelectric operations, predation, and water quality) affect the essential features of rearing, spawning and migration habitat in the Penobscot River watershed, they are also affecting Atlantic salmon critical habitat.

Threats to Critical Habitat within the GOM DPS

The final rule designating critical habitat for the GOM DPS identifies a number of activities that have and will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities (such as alternative energy development), mining, dams, dredging, and aquaculture. Most of these activities have or still do occur, at least to some extent, in each of the three SHRUs.

The Penobscot Bay SHRU once contained high quality Atlantic salmon habitat in quantities sufficient to support robust Atlantic salmon populations. The mainstem Penobscot has the highest biological value to the Penobscot Bay SHRU because it provides a central migratory corridor crucial for the entire Penobscot Bay SHRU. 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 Penobscot Bay SHRU. A combined total of 24 FERC-licensed hydropower dams in the Penobscot Bay SHRU significantly impede the migration of Atlantic salmon and other diadromous fish to nearly 300,000 units of historically accessible spawning and rearing habitat. Agriculture and urban development largely affect the lower third of the Penobscot Bay SHRU below the Piscataquis River sub-basin by reducing substrate and cover, reducing water quality, and elevating water temperatures. Introductions of smallmouth bass and other non-indigenous species significantly degrade habitat quality throughout the mainstem Penobscot and portions of the Mattawamkeag, Piscataquis, and lower Penobscot sub-basins by altering predator/prey relationships. Similar to smallmouth bass, recent Northern pike introductions threaten habitat in the lower Penobscot River.

Today, dams are the greatest impediment, outside of marine survival, to the recovery of salmon in the Penobscot, Kennebec and Androscoggin river basins (Fay *et al.* 2006). Hydropower dams in the Merrymeeting Bay SHRU significantly impede the migration of Atlantic salmon and other diadromous fish and either reduce or eliminate access to roughly 352,000 units of historically accessible spawning and rearing habitat. In addition to hydropower dams, agriculture and urban development largely affect the lower third of the Merrymeeting Bay SHRU by reducing substrate and cover, reducing water quality, and elevating water temperatures. Additionally, smallmouth bass and brown trout introductions, along with other non-indigenous species, significantly degrade habitat quality throughout the Merrymeeting Bay SHRU by altering natural predator/prey relationships.

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

3.3. Shortnose Sturgeon

The section below describes the shortnose sturgeon life history and population trends; in addition, various factors affecting the survival of the species throughout their range are highlighted. Below, we also provide a description of the status of shortnose sturgeon in the action area and provide information on the use of the action area by shortnose sturgeon.

3.3.1. Species Description

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

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

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Laboratory studies suggest that young sturgeon move downstream in a 2-step migration; a 2- to 3-day migration by larvae followed by a residency period by young of the year (YOY), then a resumption of migration by yearlings in the second summer of life (Kynard 1997). Juvenile shortnose sturgeon (between 3-10 years of age) reside in the interface between saltwater and freshwater in most rivers (NMFS 1998).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah and Delaware Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8ºC, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell *et al.* 1984, NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 12º, and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell *et al.* 1984, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.* 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

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

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell *et al.* 1984, Hall *et al.* 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell *et al.* 1984, Buckley and Kynard 1985, O'Herron *et al.* 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and

Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney *et al.* 1992, Rogers *et al.* 1994, Rogers and Weber 1995, Weber 1996).

The temperature preference for shortnose sturgeon is not known (Dadswell *et al.* 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2-3ºC (Dadswell *et al.* 1984) and as high as 34ºC (Heidt and Gilbert 1978). However, temperatures above 28ºC are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28-30ºC during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges.

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

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

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS) of shortnose sturgeon under the ESA. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

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

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

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

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

In 2007 NMFS initiated a five-year status review to assess the status of shortnose sturgeon rangewide. The status review team was specifically charged with analyzing new genetic data to inform the current understanding of shortnose sturgeon genetics rangewide. Although these analyses are not yet available, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete.

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

3.3.2. Status and Trends of Shortnose Sturgeon Rangewide

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the Saint John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (NMFS 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) and Merrimack Rivers (~100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the Saint John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain *et al.* 1998). As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for five of 11 surveyed northern populations and all natural southern populations. Kynard (1996) indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the Saint John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed; however, overall the species trend is considered to be stable.

3.3.3. Status of Shortnose Sturgeon in the Action area

On June 30, 1978, one shortnose sturgeon was captured in Penobscot Bay during finfish sampling conducted by the MDMR (Squiers and Smith 1979). As shortnose sturgeon were thought to rarely participate in coastal migrations and are known to complete their entire life history in their natal river, researchers concluded that this sturgeon was a member of a previously undocumented Penobscot River population of shortnose sturgeon. The river had long been suspected of supporting a shortnose sturgeon population based on anecdotal evidence of shortnose sturgeon capture and observation in combination with archeological data which suggested that sturgeon from the Penobscot River were used by native peoples (Knight 1985 and Petersen and Sanger 1986 in NMFS 1998; see also Fernandes *et al.* 2010).

In 1994 and 1995, researchers attempted to document the use of the Penobscot River by shortnose sturgeon. Nets were set near the head of tide in both years with the goal of capturing spawning adults. This was the only area of the river targeted by the researchers. Researchers fished for approximately 409 net hours. No shortnose sturgeon were captured. However, even in rivers with relatively large populations with intense sampling programs (*i.e.*, the Connecticut River), it is not uncommon for there to be a year when no migration to the spawning grounds and subsequently no spawning occurs.

The 1978 capture, in conjunction with historical and anecdotal evidence and the habitat characteristics of the river, led NMFS to conclude that there was a small persistent population of shortnose sturgeon in the Penobscot River (NMFS 1998).

In May 2006, the University of Maine (UM), in conjunction with NMFS and the U.S. Geological Survey (USGS), began a study of the distribution, abundance, and movements of adult and sub-adult Atlantic sturgeon in the Penobscot River. These research efforts confirmed the presence of shortnose sturgeon in the river. In 2006, 62 individual shortnose sturgeon were captured by UM in the Penobscot River from Frankfort upstream to Bangor. Between May 21, 2007, and September 10, 2007, an additional 99 individual shortnose sturgeon were captured and tagged in the river (Fernandes 2008, Fernandes *et al.* 2010). A total of 185 shortnose sturgeon were captured in the river in 2008 and 221 in 2009. To date, a total of 662 shortnose sturgeon have been captured in the Penobscot River (Dionne 2010 in MDMR 2010). All sturgeon captured during the study were adults or large juveniles as the type of gear used for sampling (large mesh gill nets of six inch and 12 inch stretch) is not designed to capture sturgeon less than two feet in length.

Using the 2006 and 2007 mark-recapture data, UM researchers used two different calculation methods to obtain a preliminary population estimate for the Penobscot River (Fernandes *et al.* 2008). Using a Lincoln/Peterson Index, an estimate of 1,049 fish was calculated (95% confidence interval of 673 and 6,939). A Schnabel estimate was also calculated yielding an estimate of 1710 shortnose sturgeon. It must be noted that both models assume a closed population (no mortality, birth or migration takes place). Fernandes (2008) used capture data from 2006 and 2007 to calculate Peterson and Schnabel estimates of abundance. The Peterson estimate of shortnose sturgeon abundance was 1,425 with a confidence interval of 203-2,647. The Schnabel estimate was 1,531 with a confidence interval of 885-5,681. As reported by Fernandes (2008), these two methods require a large number of recaptures for a precise estimate of abundance, and were likely affected by the low number of recaptures in this study. Additionally, several of the assumptions of these tests were violated, including the lack of a closed population and random sampling. A POPAN Jolly-Seber open population model completed in 2010 estimated approximately 1654 (95%CI: 1,108-2,200) adult shortnose sturgeon using the Penobscot River. Similarly, a more robust design analysis with closed periods in the summer and late fall, estimated seasonal adult abundance ranging from 636-1,285 (weighted mean), with a low estimate of 602 (95%CI: 409.6-910.8) and a high of 1,306 (95% CI: 795.6-2,176.4).

As noted above, several population estimates have been made for the Penobscot River, ranging from 602-1654 adult shortnose sturgeon (Fernandes 2008, Fernandes *et al.* 2010, Zydlewski *et al.* 2010 in MDMR 2010). It is currently unknown whether spawning is occurring in the Penobscot River or whether shortnose sturgeon present in the Penobscot River spawn in the Kennebec and/or Androscoggin River. Tracking data has shown that there is at least limited exchange between the Penobscot River and the Kennebec River. The most recent estimate of the number of shortnose sturgeon in the Kennebec complex is 9,488 and successful spawning has been confirmed in both the Kennebec and Androscoggin Rivers. The MDMR conducted studies of shortnose sturgeon in the Kennebec River from 1996 through 2001. A Schnabel estimate using tagging and recapture data from 1998, 1999 and 2000 indicates a population estimate of 9,488 (95% CI: 6,942 to 13,358) for the estuarine complex. Based on comparison to older population estimates, NMFS believes that the Kennebec River population is increasing slightly or is stable. Without historical data to compare to the current Penobscot River population estimate, it is not possible to assess the population trend.

Currently, shortnose sturgeon are limited to the area below Veazie Dam. Existing fish passage facilities at the Veazie Dam are not used by shortnose sturgeon and no shortnose sturgeon are known to occur upstream of the dam. Historically, the first natural obstacle to sturgeon migration on the Penobscot River may have been the falls at Milford, approximately rkm 70 (L. Flagg, MDMR, pers. comm 1998). If sturgeon were able to ascend the falls at Milford, they could have migrated without obstruction to Mattaseunk (rkm 171). The currently available information on the distribution of shortnose sturgeon in the Penobscot River is summarized below.

Recaptures of tagged fish and telemetry studies indicate that while shortnose sturgeon are present in the river and estuary throughout the year, their movements vary by season in response to water temperature and flow. From mid-October to mid-April most tagged shortnose sturgeon concentrate in a relatively small section of river in the Bangor area. Following this overwintering period they move downstream into the estuary, until returning upstream in summer during low flows. Tagged fish were observed to move as far upstream as two kilometers (1.2 miles) below the Veazie Dam by August. At the end of summer, shortnose sturgeon moved downstream to the location of the overwintering site in the Bangor area (Fernandes 2008, Zydlewski 2009b).

UM researchers captured 17 shortnose sturgeon in the reach of the Penobscot River between Sedgeunkedunk Stream (river kilometer 36.4) and an asphalt plant in Bangor (river kilometer 38.5) from September 28 to October 19, 2006. Additionally, in 2006, 12 of 14 (86%) shortnose sturgeon tagged with hydroacoustic transmitters were detected during the winter months in an approximately 7,500 foot section of the Penobscot River from the confluence of Sedgeunkedunk Stream upstream to the City of Bangor's waste water treatment facility. In 2011, sturgeon moved further upstream immediately above the old Bangor dam site into an area referred to as the Bangor headpond located in Ecozone 1 (river kilometer 43). Tracking data indicate that sturgeon begin moving into this reach of the Penobscot River in October and depart in April. Some adults start moving back into the vicinity of this area in June. This information indicates that the area around the Bangor water treatment facility and Sedgeunkedunk Stream is likely used as an overwintering area for shortnose sturgeon. These movements are consistent with movements of shortnose sturgeon in other river systems, including the Delaware and Kennebec Rivers. In these river systems, the majority of shortnose sturgeon have moved to the overwintering area by the time water temperatures reach 10°C in the fall, although some move to the overwintering area much sooner and others do not appear to move to the primary overwintering area at all.

The preliminary telemetry data collected by UM suggests that sub-adult and adult shortnose sturgeon move extensively within the river system during spring and early summer and often can be found over mudflats outside the main river channel (Fernandes *et al.* 2010).

Based on life history information from other rivers, adult shortnose sturgeon in the Penobscot River would likely spawn downstream of the Veazie Dam when water temperatures are between 8 and 18°C. Based on studies of spawning shortnose sturgeon in other rivers, spawning areas likely have depths of 1-5 meters with water velocity between 50-125 cm/s and cobble/rubble substrate (101-300 mm diameter). In 2009, spawning mats and ichthyoplankton nets were used to detect potential spawning below Veazie Dam (Zydlewski 2009a). While no actual spawning activity was detected, suitable spawning areas were described, using data on bathymetry, water temperature and velocity (Zydlewski 2009a). Although spawning areas have not yet been identified, researchers suspect that based on the literature, spawning likely occurs as far upriver as sturgeon can migrate. This allows larvae and juveniles the most freshwater habitat downriver before they enter estuarine conditions. Accordingly, spawning habitat suitability (based on data on substrate and water velocity during predicted spawning periods) was much higher downstream in the vicinity of the former Bangor Dam, and essentially non-existent immediately below Veazie Dam (Zydlewski 2009a).

Adults are known to rapidly leave the area after spawning and move to downstream foraging areas. Adults may also briefly visit more saline reaches of the estuary as is seen in the Connecticut and Merrimack Rivers. Typically, in the fall when water temperatures drop to 10°C, shortnose sturgeon move to upstream overwintering areas. In the Penobscot, water temperatures of approximately 13ºC seem to trigger movement to upstream concentration areas. In some river systems (Hudson, Connecticut), individual overwintering areas are segregated between spawners and non-spawners. In the Penobscot River, the distance to be traveled to the presumed spawning grounds is relatively short and in close proximity to overwintering areas as is seen in other rivers with small amounts of available habitat (*e.g.*, the Merrimack River). Eggs and larvae are likely concentrated near the spawning area for up to four weeks post-spawning, after which larvae disperse into the tidal river. As juvenile sturgeon are believed to remain upstream of the salt wedge until they are about 45 cm long (Crance 1986), it is likely that juvenile sturgeon would occur in the Penobscot River from the Veazie Dam downstream to the Town of Hampden, a stretch of river approximately 16 km long.

Based upon data collected by UM, known life history characteristics of shortnose sturgeon, and habitat availability in the Penobscot River, juvenile and adult shortnose sturgeon have the potential to occur in the action area at various times of the year.

Outside of spawning, shortnose sturgeon typically occur over soft substrates consisting of mud, silt or sand, and commonly in deeper channels or over tidal mud flats (NMFS 1998). Such habitat is extensive in the Penobscot River from the estuary upstream to the area around Bangor and Brewer (Fernendes 2008, Zydlewski 2009a, Zydlewski 2009b). Much of this soft sediment consists of bark, sawdust or wood chips, which were deposited as a result of log-driving and operation of saw mills and pulp and paper operations on the river. These soft sediment areas were found to be used by shortnose sturgeon throughout the year in recent UM studies (Fernendes 2008).

Recent data collected by UM and MDMR indicate that migration between river systems is more extensive than was previously thought. As summarized by Dionne (2010a in MDMR 2010), between 2006 and 2009 a total of 68 shortnose sturgeon were implanted with coded acoustic transmitters. Of the 46 active acoustically tagged individuals, 13 remained within the Penobscot River system. These fish demonstrated an in-river migration pattern that involved downriver movement from the wintering area in the spring, followed by gradual upriver movement throughout the summer prior to returning to the wintering area in the fall (Fernandes *et al.* 2010). Eleven individuals were characterized as “spring emigrants.” These fish followed a similar in-river movement pattern to resident fish but made a single migration out of the Penobscot River system in the spring (April 12 – May 11) while the resident fish remained in the estuary. These fish largely returned to the Penobscot River within two months (May 25 – July 7); with one fish remaining outside the Penobscot River for approximately one year. Fifteen tagged fish were determined to be “fall emigrants”. These fish followed the typical in-river migration pattern while in the river, with the exception of using the Kennebec River overwintering site. These fish utilized the Penobscot River from mid-spring through early fall (entering between April 19 and June 19 and leaving between September 9 and November 4). The remaining seven tagged fish were classified as “summer emigrants”. The movements of these fish were not as well defined; these fish were observed leaving the Penobscot between June 1 and July 1 with some individuals overwintering in the Penobscot and some in the Kennebec. Returns to the Penobscot were made between April 26 and June 8. At least one of these fish spent over three months in coastal river systems between the Penobscot and Kennebec Rivers.

Research has been conducted by the New York University School of Medicine involving mitochondrial DNA (mtDNA) analysis of shortnose sturgeon populations, including fish caught in the Penobscot River (Wirgin *et al.* in progress). Information available to date for the Penobscot samples indicates that haplotype frequencies in this population were almost identical to that in the Kennebec River system. Additionally, the Penobscot River samples did not exhibit any haplotypes that were not seen elsewhere. It is unknown at this time whether shortnose sturgeon in the Penobscot River are the descendants of recent migrants from the Kennebec River, migrants themselves or whether they represent a remnant naturally reproducing Penobscot River population. It is possible that the adults captured to date are representatives of all three scenarios. As the sample size is very small and as mtDNA represents only a fraction (less than 1%) of the genetic material and is maternally inherited, it is difficult to make conclusive statements regarding the potential for fish in the Penobscot River to be genetically distinct from other fish in the Kennebec complex. However, as there were no unique haplotypes in the Penobscot River fish and unique haplotypes are seen in almost every other population, the best available information suggests that fish occurring in the Penobscot River are not genetically unique and are not genetically distinct from other fish in the Kennebec River. Nuclear DNA analysis (King *et al.* 2010) finds that the Kennebec, Androscoggin, and Penobscot Rives form a metapopulation that are genetically indistinguishable from each other; reflecting a panmictic population.

3.3.4. Factors Affecting Shortnose Sturgeon in the Action Area

3.3.4.1. Dams and Hydroelectric Facilities

As noted above, the range of shortnose sturgeon in the Penobscot River has been restricted by the Veazie Dam. This dam restricts the available habitat for shortnose sturgeon. In rivers where shortnose sturgeon have free access (*i.e.*, there are no dams), the species typically has a 100-200 kilometer range. In the Penobscot River, this range is restricted to only 25 miles of mainstem river, with an additional 20 miles of estuary available below the mouth of the river. The Veazie Dam and Great Works dam prevent shortnose sturgeon from accessing historically available habitat above the Dam, which is thought to have extended to at least Milford Falls (approximately rkm 70). These Dams have also likely prevented the species from spawning at their preferred spawning habitat, which is likely located upstream of the Veazie Dam. The lack of accessibility to this habitat has likely had a significant negative effect on shortnose sturgeon in this river system and will continue to delay recovery of this species in the Penobscot River. Because no shortnose sturgeon are known to occur upstream of any hydroelectric projects in the Penobscot River, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in the action area. The extent that shortnose sturgeon are affected by operations of hydroelectric facilities in the Penobscot River is currently unknown. Additionally, to the extent that upstream hydroelectric projects affect conditions below Veazie Dam, shortnose sturgeon are affected by the operation of these projects as well. The Veazie Dam is slated for removal within the timeframe of this action.

3.3.4.2. Contaminants and Water Quality

Shortnose sturgeon are vulnerable to effects from contaminants and water quality over their entire life history. In addition, their long life span increases the potential for environmental contaminants to build up in the tissue which may affect the development of the individual or its gametes. Point source discharges (*i.e.*, municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (*i.e.*, metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality that may also impact the health of individual sturgeon. The compounds associated with discharges can alter the chemistry and temperature of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival. Contaminants including heavy metals, PAHs, pesticides, and PCBs, can have serious, deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). Contaminants introduced into the water column or through the food chain eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable. In 2000, the US Environmental Protection Agency (EPA) delegated authority for the NPDES permit program to the State of Maine. Currently, NMFS reviews and comments on all NPDES issued for discharges to the Penobscot River occurring below the Veazie Dam. In general, water quality has improved in the Penobscot River and Gulf of Maine over the past decades (Lichter *et al.* 2006, EPA 2008). However, water quality issues that derive from wastewater treatment plants and power plants are still a concern for all life stages of shortnose sturgeon as effects may be long-lasting.

3.3.5. Summary of factors affecting Recovery of Shortnose Sturgeon

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

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon rangewide. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979, Dovel *et al.* 1992, Collins *et al. 1*996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are taken, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with re-suspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

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

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

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the “adverse affect” range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of 14 metals, one semivolatile compound, one PCB Aroclor, PCDDs and PCDFs in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

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

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

3.4. Atlantic Sturgeon

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

3.4.1. *Species Description*

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott 1988, ASSRT 2007, T. Savoy, CT DEP, pers. comm.). On February 6, 2012, NMFS published notice in the Federal Register listing the New York Bight (NYB), Chesapeake Bay, Carolina, and South Atlantic DPSs as "endangered," and the GOM DPS as "threatened" (77 FR 5880 and 77 FR 5914) (Figure 6). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings.

The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King 2011). However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine and riverine environment that occur far from natal spawning rivers.

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

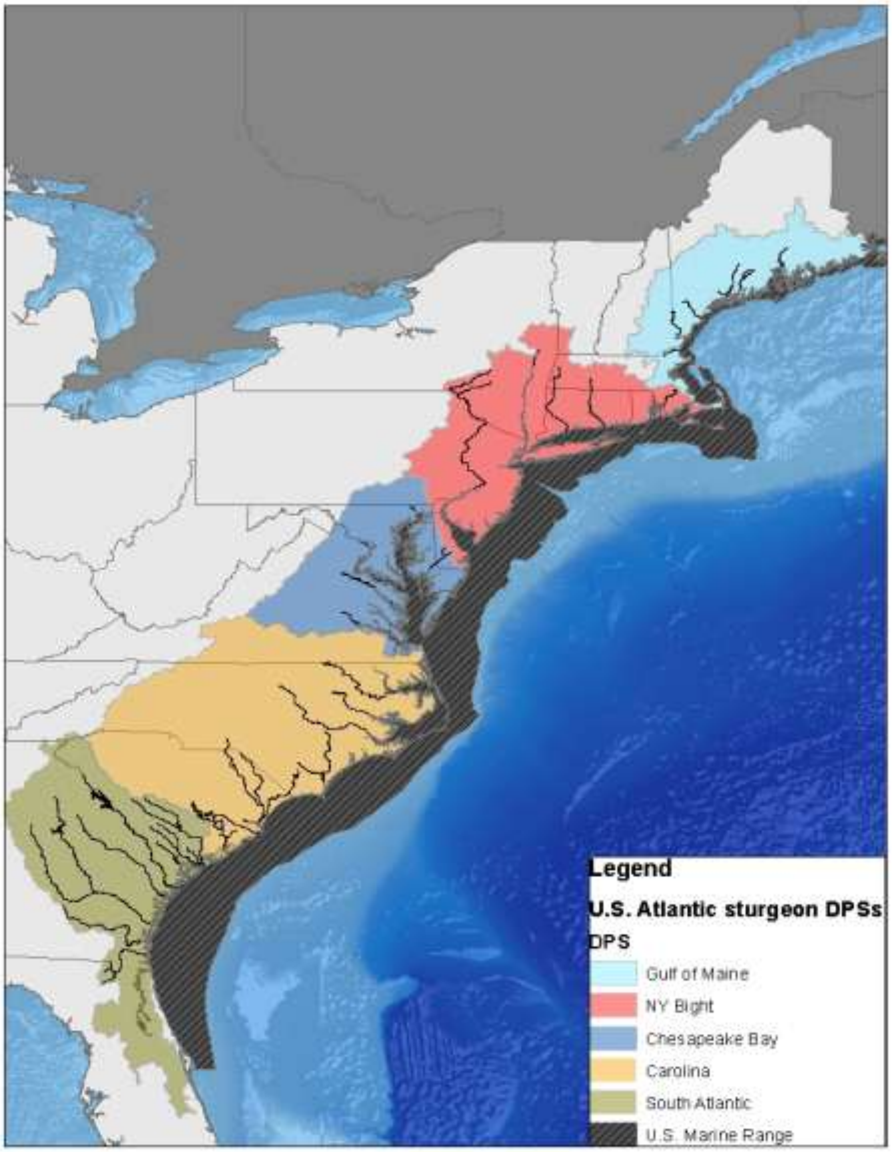

Figure 6. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs

Atlantic sturgeon life history

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous fish (Bigelow and Schroeder 1953, Vladykov and Greeley 1963, Mangin 1964, Pikitch *et al. 2*005, Dadswell 2006, ASSRT 2007). The life history of Atlantic sturgeon can be divided up into five general categories (Table 8).

Table 7. Descriptions of Atlantic sturgeon life history stages (adapted from Mohler 2003, Atlantic Sturgeon Status Review Team 2007).

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

Atlantic sturgeon are a relatively large fish, even amongst sturgeon species (Pikitch *et al.* 2005). Atlantic sturgeon are bottom feeders that suck food into a ventrally-located protruding mouth (Bigelow and Schroeder 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder 1953, ASSRT 2007, Guilbard *et al.*2007, Savoy 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder 1953, ASSRT 2007, Guilbard *et al.* 2007).

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e., length) than fully mature males; and (4) the length of Atlantic sturgeon caught since the mid-late 20th century have typically been less than three meters (Smith *et al.*1982, Smith *et al.* 1984, Smith 1985, Scott and Scott 1988, Young *et al.* 1988, Collins *et al.* 2000, Caron *et al.* 2002, Dadswell 2006, ASSRT 2007, Kahnle *et al 2*007, DFO 2011). The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 meters (Vladykov and Greeley 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.* 1982, Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998, Dadswell 2006). However, while females are prolific with egg production ranging from 400,000 to 4,000,000 eggs per spawning year, females spawn at intervals of two to five years (Vladykov and Greeley 1963, Smith *et al.* 1982, Van Eenennaam *et al.* 1996, Van Eenennaam and Doroshov 1998, Stevenson and Secor 1999, Dadswell 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman 1997). Males exhibit spawning periodicity of one to five years (Smith 1985, Collins *et al.* 2000, Caron *et al.* 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (ASMFC 2009). Spawning migrations generally occur during February-March in southern systems; April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco 1977, Smith 1985, Bain 1997, Smith and Clugston 1997, Caron *et al.* 2002). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43° F) (Smith *et al.* 1982, Dovel and Berggren 1983, Smith 1985, ASMFC 2009), and remain on the spawning grounds throughout the spawning season (Bain 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren 1983, Smith 1985, Collins *et al.* 2000), make rapid spawning migrations upstream, and quickly depart following spawning (Bain1997).

The spawning areas in most U.S. rivers have not been well defined. However, the habitat characteristics of spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 cm/s and depths are 3-27 meters (Borodin 1925, Dees 1961, Leland 1968, Scott and Crossman 1973, Crance 1987, Shirey *et al.* 1999, Bain *et al.* 2000, Collins *et al.* 2000, Caron *et al.* 2002, Hatin *et al.* 2002, ASMFC 2009). Sturgeon eggs are deposited on hard bottom substrate such as cobble, coarse sand, and bedrock (Dees 1961, Scott and Crossman 1973, Gilbert 1989, Smith and Clugston 1997, Bain *et al.* 2000, Collins *et al.* 2000, Caron *et al.* 2002, Hatin *et al.* 2002, Mohler 2003, ASMFC 2009), and become adhesive shortly after fertilization (Murawski and Pacheco 1977, Van den Avyle 1983, Mohler 2003). Incubation time for the eggs increases as water temperature decreases (Mohler 2003). At temperatures of 20° and 18° C, hatching occurs approximately 94 and 140 hours, respectively, after egg deposition (ASSRT 2007).

Larval Atlantic sturgeon (i.e. less than four weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam *et al.* 1996) are assumed to undertake a demersal existence and inhabit the same riverine or estuarine areas where they were spawned (Bain *et al. 2*000, Kynard and Horgan 2002, ASMFC 2009). Studies suggest that age zero (i.e., young-of-year), age one, and age two juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley 1999, Hatin *et al.* 2007, McCord *et al.* 2004, Munro *et al.* 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.* 2000*).* Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton 1973, Dovel and Berggen 1983, Waldman *et al.* 1996, Dadswell 2006, ASSRT 2007).

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

3.4.2. *Determination of DPS Composition in the Action Area*

As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated. We have determined that Atlantic sturgeon in the action area are likely to originate from two of the five ESA listed DPSs as well as from the St. John River in Canada. Fish originating from the St. John River are not listed under the ESA. Currently, if the fish does not have an identifying tag, the only way to tell the river (or DPS) of origin for a particular individual is by genetic sampling. The distribution of Atlantic sturgeon is influenced by geography, with Atlantic sturgeon from a particular DPS becoming less common the further you are from the river of origin. Areas that are geographically close are expected to have a similar composition of individuals. The nearest area to the action area for which mixed stock analysis is available is the Bay of Fundy, Canada. In this area, 63% of individuals are Canadian (St. John River) origin, 36% are GOM DPS origin and 1% are NYB origin. We do not currently have a mixed stock analysis for the action area. In the Penobscot River, we expect the composition to be similar to that in the Bay of Fundy; however, we expect that GOM DPS individuals will be more frequent than Canadian origin individuals. Therefore, in the action area, we expect Atlantic sturgeon to occur at the following frequencies: St. John River (Canada) 36%, Gulf of Maine DPS 63% and New York Bight DPS 1%. This assumption is supported by some preliminary genetic analyses of fish caught in rivers within the Gulf of Maine; these results demonstrate that the fish are predominantly of Gulf of Maine origin with some St. John River and Hudson River fish present. The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation, we have selected the reported values above, which approximate the mid-point of the range, as a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail in Damon-Randall *et al.* (2012).

3.4.3. *Status and Trends of Atlantic Sturgeon Rangewide*

Distribution and Abundance

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and Crossman 1973, Taub 1990, Kennebec River Resource Management Plan 1993, Smith and Clugston 1997, Dadswell 2006, ASSRT 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware, and at least 10,000 females for other spawning stocks (Secor and Waldman 1999, Secor 2002). Historical records suggest that Atlantic sturgeon spawned in at least 38 rivers prior to this period. Currently, only 20 U.S. rivers are known to support spawning based on available evidence (i.e., presence of young-of-year or gravid Atlantic sturgeon documented within the past 15 years) (ASSRT 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only four rivers (Kennebec, Hudson, Delaware, James) are known to currently support spawning from Maine through Virginia where historical records support there used to be fifteen spawning rivers (ASSRT 2007). Thus, there are substantial gaps in the range between Atlantic sturgeon spawning rivers amongst northern and mid-Atlantic states which could make recolonization of extirpated populations more difficult.

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

3.4.4. *Threats Faced by Atlantic sturgeon throughout their range*

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

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

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

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters (DFO 2011). Sturgeon belonging to one or more of the DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the Gulf of Maine and the New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO 2011, Wirgin and King 2011). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), the U.S. and Canada are currently working on a conservation strategy to address the potential for captures of U.S. fish in Canadian directed Atlantic sturgeon fisheries and of Canadian fish incidentally in U.S. commercial fisheries. At this time, there are no estimates of the number of individuals from any of the DPSs that are captured or killed in Canadian fisheries each year.

Based on geographic distribution, most U.S. Atlantic sturgeon that are intercepted in Canadian fisheries are likely to originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Fisheries bycatch in U.S. waters is a threat faced by all 5 DPSs. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Federal FMPs (NMFS NEFSC 2011) in the Northeast Region but do not have a similar estimate for Southeast fisheries. We also do not have an estimate of the number of Atlantic sturgeon captured or killed in state fisheries. At this time, we are not able to quantify the effects of other significant threats (e.g., vessel strikes, poor water quality, water availability, dams, and dredging) in terms of habitat impacts or loss of individuals. While we have some information on the number of mortalities that have occurred in the past in association with certain activities (e.g., mortalities in the Delaware and James rivers that are thought to be due to vessel strikes), we are not able to use those numbers to extrapolate effects throughout one or more DPS. This is because of (1) the small number of data points and, (2) lack of information on the percent of incidences that the observed mortalities represent.

As noted above, the NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by Northeast FMPs (NEFSC 2011). The analysis prepared by the NEFSC estimates that from 2006 through 2010 there were 2,250 to 3,862 encounters per year in observed gillnet and trawl fisheries, with an average of 3,118 encounters. Mortality rates in gillnet gear are approximately 20%. Mortality rates in otter trawl gear are believed to be lower at approximately 5%.

3.4.5. *Gulf of Maine DPS of Atlantic sturgeon*

The GOM DPS of Atlantic sturgeon includes the following: all anadromous Atlantic sturgeon that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT 2007). Spawning still occurs in the Kennebec River, and it is also possible that it still occurs in the Androscoggin and Penobscot Rivers as well. The capture of a larval Atlantic sturgeon during the 2011 spawning season below the Brunswick Dam by MDMR suggests that spawning may be occurring in the Androscoggin River. There is no evidence of recent spawning in the remaining rivers.

In the 1800s, construction of the Essex Dam on the Merrimack River at river kilometer (rkm) 49 blocked access to 58 percent of Atlantic sturgeon habitat in the river (Oakley 2003, ASSRT 2007). However, the accessible portions of the Merrimack seem to be suitable habitat for Atlantic sturgeon spawning and rearing (i.e., nursery habitat) (Keiffer and Kynard 1993). Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in the Merrimack River.

Studies are on-going to determine whether Atlantic sturgeon are spawning in these rivers. Atlantic sturgeon that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the GOM DPS as well as likely throughout the entire range (ASSRT 2007, Fernandes *et al.* 2010).

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (Squiers *et al.* 1981, ASMFC 1998, NMFS and USFWS 1998). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (i.e., expressing milt) in July 1994 below the (former) Edwards Dam; (2) capture of 31 adult Atlantic sturgeon from June 15,1980, through July 26,1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least four ripe males and one ripe female captured on July

26,1980; and, (3) capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (NMFS and USFWS 1998, ASMFC 2007). The low salinity values for waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

Several threats play a role in shaping the current status of GOM DPS Atlantic sturgeon. Historical records provide evidence of commercial fisheries for Atlantic sturgeon in the Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers *et al.* 1979). In 1849, 160 tons of sturgeon were caught in the Kennebec River by local fishermen (Squiers *et al.* 1979). Following the 1880's, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. All directed Atlantic sturgeon fishing in all states has been prohibited since 1998, and retention of Atlantic sturgeon bycatch in and from the Exclusive Economic Zone (EEZ) has been prohibited since 1999. Nevertheless, mortalities associated with bycatch in fisheries occurring in state and federal waters still occurs. In the marine range, GOM DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.* 2004, ASMFC 2007). As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

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

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin and Saco Rivers, these dams are near the site of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown; however, as noted above, the documentation of an Atlantic sturgeon larva downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie and Great Works Dams.

Together these dams prevent Atlantic sturgeon from accessing approximately 22 river kilometers of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam (Trinko Lake *et al.* 2012). While removal of the Veazie and Great Works Dams is anticipated to occur in the near future, the presence of these dams is currently preventing access to significant habitats within the Penobscot River. While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie and Great Works Dams affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River, but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

GOM DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Gulf of Maine over the past decades (Lichter *et al. 2*006, USEPA 2008). Many rivers in Maine, including the Androscoggin River, were heavily polluted in the past from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

There are no empirical abundance estimates for the GOM DPS. The Atlantic sturgeon SRT (2007) presumed that the GOM DPS was comprised of less than 300 spawning adults per year, based on abundance estimates for the Hudson and Altamaha River riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized, adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies.

Summary of the Gulf of Maine DPS

Spawning for the GOM DPS is known to occur in only one river (Kennebec). Although it may be occurring in other rivers, such as the Sheepscot or Penobscot, it has not been confirmed. There are indications of increasing abundance of Atlantic sturgeon belonging to the GOM DPS. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River, and are observed in rivers where they were unknown to occur or had not been observed to occur for many years (e.g., the Saco, Presumpscot, and Charles rivers). These observations suggest that abundance of the GOM DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for this DPS.

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

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

3.4.6. *New York Bight DPS of Atlantic sturgeon*

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

The Hudson River and Estuary extend 504 kilometers from the Atlantic Ocean to Lake Tear of-the-Clouds in the Adirondack Mountains (Dovel and Berggren 1983). The estuary is 246 km long, beginning at the southern tip of Manhattan Island (rkm 0) and running north to the Troy Dam (rkm 246) near Albany (Sweka *et al.* 2007). All Atlantic sturgeon habitats are believed to occur below the dam. Therefore, presence of the dam on the river does not restrict access of Atlantic sturgeon to necessary habitats (e.g., for spawning, rearing, foraging, over wintering) (NMFS and USFWS 1998, ASSRT 2007).

Use of the river by Atlantic sturgeon has been described by several authors. Briefly, spawning likely occurs in multiple sites within the river from approximately rkm 56 to rkm 182 (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996, Kahnle *et al.* 1998, Bain *et al.* 2000). Selection of sites in a given year may be influenced by the position of the salt wedge (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996, Kahnle *et al.* 1998). The area around Hyde Park (approximately rkm134) has consistently been identified as a spawning area through scientific studies and historical records of the Hudson River sturgeon fishery (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996, Kahnle *et al.* 1998, Bain *et al.* 2000). Habitat conditions at the Hyde Park site are described as freshwater year round with bedrock, silt and clay substrates and waters depths of 12-24 m (Bain *et al.* 2000). Bain *et al.* (2000) also identified a spawning site at rkm 112 based on tracking data. The rkm 112 site, located to one side of the river, has clay, silt and sand substrates, and is approximately 21-27 m deep (Bain *et al.* 2000).

Young-of-year (YOY) have been recorded in the Hudson River between rkm 60 and rkm 148, which includes some brackish waters; however, larvae must remain upstream of the salt wedge because of their low salinity tolerance (Dovel and Berggren 1983, Kahnle *et al.* 1998, Bain *et al.* 2000). Catches of immature sturgeon (age 1 and older) suggest that juveniles utilize the estuary from the Tappan Zee Bridge through Kingston (rkm 43- rkm 148) (Dovel and Berggren 1983, Bain *et al.* 2000). Seasonal movements are apparent with juveniles occupying waters from rkm 60 to rkm 107 during summer months and then moving downstream as water temperatures decline in the fall, primarily occupying waters from rkm 19 to rkm 74 (Dovel and Berggren 1983, Bain *et al.* 2000). Based on river-bottom sediment maps (Coch 1986) most juvenile sturgeon habitats in the Hudson River have clay, sand, and silt substrates (Bain *et al.* 2000). Newburgh and Haverstraw Bays in the Hudson River are areas of known juvenile sturgeon concentrations (Sweka *et al.* 2007). Sampling in spring and fall revealed that highest catches of juvenile Atlantic sturgeon occurred during spring in soft-deep areas of Haverstraw Bay even though this habitat type comprised only 25% of the available habitat in the Bay (Sweka *et al.* 2007). Overall, 90% of the total 562 individual juvenile Atlantic sturgeon captured during the course of this study (14 were captured more than once) came from Haverstraw Bay (Sweka *et al.* 2007). At around three years of age, Hudson River juveniles exceeding 70 cm total length begin to migrate to marine waters (Bain *et al.* 2000).

In general, Hudson River Atlantic sturgeon mature at approximately 11 to 21 years of age (Dovel and Berggren 1983, ASMFC 1998, Young *et al. 1*998). A sample of 94 pre-spawning adult Atlantic sturgeon from the Hudson River was comprised of males 12 to 19 years old, and females that were 14 to 36 years old (Van Eenennaam *et al.* 1996). The majority of males were 13 to 16 years old while the majority of females were 16 to 20 years old (Van Eenennaam *et al.* 1996). These data are consistent with the findings of Stevenson and Secor (1999) who noted that, amongst a sample of Atlantic sturgeon collected from the Hudson River fishery from 1992-1995, growth patterns indicated males grew faster and, thus, matured earlier than females. The spawning season for Hudson River Atlantic sturgeon extends from late spring to early summer (Dovel and Berggren 1983, Van Eenennaam *et al.* 1996).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800's is unknown but, has been conservatively estimated at 10,000 adult females (Secor 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor 2002, ASSRT 2007, Kahnle *et al.* 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007). Kahnle *et al.* (1998, 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-

1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid 1970's (Kahnle *et al.* 1998). A decline appeared to occur in the mid to late 1970's followed by a secondary drop in the late 1980's (Kahnle *et al.* 1998, Sweka *et al.* 2007, ASMFC 2010). Catch-per-unit-effort data suggest that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980's (Sweka *et al.* 2007, ASMFC 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and while the CPUE is generally higher in the 2000s as compared to the 1990s, given the significant annual fluctuation it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s. There is currently not enough information regarding any life stage to establish a trend for the Hudson River population.

In the Delaware River and Estuary, Atlantic sturgeon occur from the mouth of the Delaware Bay to the fall line near Trenton, NJ, a distance of 220 km (NMFS and USFWS 1998, Simpson 2008). As is the case in the Hudson River, all historical Atlantic sturgeon habitats appear to be accessible in the Delaware (NMFS and USFWS 1998, ASSRT 2007). Recent multi-year studies have provided new information on the use of habitats by Atlantic sturgeon within the Delaware River and Estuary (Simpson 2008, Brundage and O'Herron 2009, Calvo *et al.* 2010, Fox and Breece 2010).

Historical records from the 1830's indicate Atlantic sturgeon may have spawned as far north as Bordentown, just below Trenton, NJ (Pennsylvania Commission of Fisheries 1897). Cobb (1899) and Borodin (1925) reported spawning occurring between rkm 77 and 130 (Delaware City, DE to Chester City, PA). Based on recent tagging and tracking studies carried out from 2009-2011, Breece (2011) reports likely spawning locations at rkm 120-150 and rkm 170-190. Mature adults have been tracked in these areas at the time of year when spawning is expected to occur and movements have been consistent with what would be expected from spawning adults. Based on tagging and tracking studies, Simpson (2008) suggested that spawning habitat also exists from Tinicum Island (rkm 136) to the fall line in Trenton, NJ (rkm 211). To date, eggs and larvae have not been documented to confirm that actual spawning is occurring in these areas. However, as noted below, the presence of young of the year in the Delaware River provides confirmation that spawning is still occurring in this river.

Sampling in 2009 that targeted YOY resulted in the capture of more than 60 YOY in the Marcus Hook anchorage (rkm 127) area during late October-late November 2009 (Fisher 2009, Calvo *et al.* 2010). Twenty of the YOY from one study and six from the second study received acoustic tags that provided information on habitat use by this early life stage (Calvo *et al.* 2010, Fisher 2011). YOY used several areas from Deepwater (rkm 105) to Roebling (rkm 199) during late fall to early spring. Some remained in the Marcus Hook area while others moved upstream, exhibiting migrations in and out of the area during winter months (Calvo *et al.* 2010, Fisher 2011). At least one YOY spent some time downstream of Marcus Hook (Calvo *et al.* 2010, Fisher 2011). Downstream detections from May to August between Philadelphia (rkm 150) and New Castle (rkm 100) suggest non-use of the upriver locations during the summer months

(Fisher 2011). By September 2010, only three of 20 individuals tagged by DE DNREC persisted with active tags (Fisher 2011). One of these migrated upstream to the Newbold Island and Roebling area (rkm 195), but was back down in the lower tidal area within three weeks and was last detected at Tinicum Island (rkm 141) when the transmitter expired in October (Fisher 2011). The other two remained in the Cherry Island Flats (rkm 113) and Marcus Hook Anchorage area (rkm130) until their tags transmissions also ended in October (Fisher 2011).

The Delaware Estuary is known to be a congregation area for sturgeon from multiple DPSs. Generally, non-natal late stage juveniles (sometimes also referred to as subadults) immigrate into the estuary in spring, establish home range in the summer months in the river, and emigrate from the estuary in the fall (Fisher 2011). Subadults tagged and tracked by Simpson (2008) entered the lower Delaware Estuary as early as mid-March but, more typically, from mid-April through May. Tracked sturgeon remained in the Delaware Estuary through the late fall departing in November (Simpson 2008). Previous studies have found a similar movement pattern of upstream movement in the spring-summer and downstream movement to overwintering areas in the lower estuary or nearshore ocean in the fall-winter (Brundage and Meadows 1982, Shirey *et al.* 1997, 1999, Brundage and O'Herron 2009, Brundage and O'Herron in Calvo *et al.* 2010).

Brundage and O'Herron (in Calvo *et al.* 2010) tagged 26 juvenile Atlantic sturgeon, including six young of the year. For non YOY fish, most detections occurred in the lower tidal Delaware River from the middle Liston Range (rkm 70) to Tinicum Island (rkm 141). For non YOY fish, these researchers also detected a relationship between the size of individuals and the movement pattern of the fish in the fall. The fork length of fish that made defined movements to the lower bay and ocean averaged 815 mm (range 651-970 mm) while those that moved towards the bay but were not detected below Liston Range averaged 716 mm (range 505-947 mm), and those that appear to have remained in the tidal river into the winter averaged 524 mm (range 485-566 mm) (Calvo *et al.* 2010). During the summer months, concentrations of Atlantic sturgeon have been located in the Marcus Hook (rkm 123-129) and Cherry Island Flats (rkm 112-118) regions of the river (Simpson 2008, Calvo *et al.* 2010) as well as near Artificial Island (Simpson 2008). Sturgeon have also been detected using the Chesapeake and Delaware Canal (Brundage 2007, Simpson 2008).

Adult Atlantic sturgeon captured in marine waters off of Delaware Bay in the spring were tracked in an attempt to locate spawning areas in the Delaware River (Fox and Breece 2010). Over the period of two sampling seasons (2009-2010) four of the tagged sturgeon were detected in the Delaware River. The earliest detection was in mid-April while the latest departure occurred in mid-June (Fox and Breece 2010). The sturgeon spent relatively little time in the river each year, generally about four weeks, and used the area from New Castle, DE (rkm 100) to Marcus Hook (rkm 130) (Fox and Breece 2010). A fifth sturgeon tagged in a separate study was also tracked and followed a similar timing pattern but traveled farther upstream (to rkm 165) before exiting the river in early June (Fox and Breece 2010).

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

Several threats play a role in shaping the current status and trends observed in the Delaware River and Estuary. In-river threats include habitat disturbance from dredging, and impacts from historical pollution and impaired water quality. A dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron 2009), and the river receives significant shipping traffic. Vessel strikes have been identified as a threat in the Delaware River; however, at this time we do not have information to quantify this threat or its impact to the population or the NYB DPS. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population.

Summary of the New York Bight DPS

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

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

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

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

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

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

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

3.4.7. *Factors Affecting Atlantic Sturgeon in Action Area*

3.4.7.1.*Dams and Hydroelectric Facilities*

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot River. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie. The Veazie Dam prevents Atlantic sturgeon from accessing approximately 22 river kilometer of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam (Trinko Lake *et al.* 2012). While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie Dam affects the likelihood of spawning occurring in this river. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the Penobscot River, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in the action area. The extent that Atlantic sturgeon are affected by operations of hydroelectric facilities in the Penobscot River is currently unknown.

3.4.7.2.*Contaminants and Water Quality*

Atlantic sturgeon are vulnerable to effects from contaminants and water quality over their entire life history. In addition, their long life span increases the potential for environmental contaminants to build up in the tissue which may affect the development of the individual or its gametes. Point source discharges (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality that may also impact the health of individual sturgeon. The compounds associated with discharges can alter the chemistry and temperature of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival. Contaminants including heavy metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs), can have serious, deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). Contaminants introduced into the water column or through the food chain eventually become associated with the benthos where bottom dwelling species like Atlantic sturgeon are particularly vulnerable.

4. ENVIRONMENTAL BASELINE

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

4.1. **Formal or Early Section 7 Consultations**

In the Environmental Baseline section of an Opinion, we discuss the anticipated impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation. Effects of Federal actions that have been completed are encompassed in the Status of the Species section of the Opinion.

On October, 24, 2007, we issued an Opinion to the ACOE on proposed dredging and construction activities by Cianbro Constructors, LLC (Cianbro) for the proposed Brewer Module Facility in Brewer, Maine. The ACOE provided a Clean Water Act Section 404 Permit and Rivers and Harbor Act Section 10 Permit to Cianbro that authorized activities occurring below the ordinary high water mark in the Penobscot River. We concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon or shortnose sturgeon. The incidental take statement (ITS) exempted the incidental taking of three shortnose sturgeon from interactions with dredging and other in-water activities, while specifying reasonable and prudent measures and implementing terms and conditions necessary to minimize the impact of these activities on shortnose sturgeon. This level of take accounts for shortnose sturgeon injured or killed during in-water work and shortnose sturgeon that may be captured by the dredge bucket but released unharmed. No take of Atlantic salmon was exempted for this project.

On April 25, 2012, we issued an Opinion to the NMFS Northeast Fisheries Science Center, Maine Field Station on the impacts to listed species from the proposed Penobscot Estuarine Fish Community and Ecosystem Survey. The NEFSC is continuing to develop and refine a long term study plan to evaluate the feasibility of various capture methods with the goal of establishing a comprehensive ecosystem survey to document the distribution and relative abundance of aquatic species in estuarine and nearshore environments of the Penobscot River. The purpose of the proposed research survey is to develop consistent sampling methods and test efficacy of a variety of sampling techniques and gear types at numerous sites to measure estuary fish communities with a focus on diadromous fish species. We concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon, shortnose sturgeon or Atlantic sturgeon. The ITS accompanying the Opinion exempted the incidental take of up to 15 Atlantic sturgeon juveniles and/or subadults (GOM and NYB DPS) and up to 32 shortnose sturgeon juveniles and/or adults. We hold an ESA section 10 (a)(l)(A) research permit (ESA permit 697823) from the USFWS. As all effects to Atlantic salmon resulting from the estuary study will be considered and authorized under this permit, take of Atlantic salmon was not exempted as part of the consultation.

On August 31, 2012, we issued an Opinion to FERC on the impacts to listed species from the proposed construction of new powerhouses at the Orono (No. 2710) and Stillwater (No. 2712) Projects; proposed fish passage improvements at the Orono, Stillwater and Milford (No. 2534) Projects; and proposed Species Protection Plan for the Orono, Stillwater, Milford, West Enfield (No. 2600) and Medway (No. 2666) Projects by Black Bear Hydro LLC (Black Bear). We concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon, shortnose sturgeon or Atlantic sturgeon. We also concluded that the proposed action would not destroy or adversely modify designated critical habitat for Atlantic salmon. The ITS accompanying the Opinion exempted the incidental take of a number of Atlantic salmon smolts and kelts and several non-lethal takes of shortnose sturgeon and Atlantic sturgeon.

4.2. Scientific Studies

Atlantic salmon

MDMR is authorized under the USFWS' endangered species blanket permit (No. 697823) to conduct monitoring, assessment, and habitat restoration activities for listed Atlantic salmon populations in Maine. The extent of take from MDMR activities during any given year is not expected to exceed 2% of any life stage being impacted; for adults, it would be less than 1%.

MDMR will continue to conduct Atlantic salmon research and management activities in Cove Brook, Ducktrap River, Penobscot River, and the Kenduskeag Stream watershed while the proposed action is carried out. The information gained from these activities will be used to further salmon conservation actions in the GOM DPS.

We are also a sub-permittee under USFWS' ESA section 10 endangered species blanket permit. Research authorized under this permit is currently ongoing with respect to Atlantic salmon in the Penobscot River. The goal of current research is to document changes in fish populations resulting from both the removal of the Veazie and Great Works Projects as well as the construction of the fish bypass at the Howland Project. The study is utilizing boat electrofishing techniques to document baseline conditions in the river prior to construction at the dams. Following dam removal and construction of the fish bypass, researchers will re-sample the river. We are also monitoring biomass and species composition in the estuary to look at system-wide effects of PRRP projects. Although these activities will result in some take of Atlantic salmon, adverse impacts are expected to be minor and such take is authorized by an existing ESA permit. The information gained from these activities will be used to further salmon conservation actions in the GOM DPS.

USFWS is also authorized under an ESA section 10 endangered species blanket permit to conduct the conservation hatchery program at the Craig Brook and Green Lake National Fish Hatcheries. The mission of the hatcheries is to raise Atlantic salmon parr and smolts for stocking into selected Atlantic salmon rivers in Maine. Over 90% of adult returns to the GOM DPS are currently provided through production at the hatcheries. Approximately 600,000 smolts are stocked annually in the Penobscot River. The hatcheries provide a significant buffer from extinction for the species.

Shortnose sturgeon

Research activities for shortnose sturgeon conducted by UM scientists are authorized through a scientific research permit (No. 1595) issued by us in 2007. This permit allows the capture of up to 100 shortnose sturgeon annually in the Penobscot River from 2007-2012 using gill nets and trammel nets. This permit has been modified several times, most recently on January 13, 2011. The current permit allows the capture of up to 200 shortnose sturgeon annually. The permit also allows tagging, tissue sampling, and boroscoping of a subset of individuals. Permit No. 1595 also authorizes UM to collect and preserve thirty shortnose sturgeon eggs to verify spawning in the Penobscot River. Mortalities of two adult or juvenile shortnose sturgeon are authorized annually. A Biological Opinion on the effects of research authorized under this permit was issued on March 27 2007. In this Opinion, we concluded that the research to be authorized under Permit No. 1595 was not likely to jeopardize the continued existence of any ESA-listed species. To date, approximately 893 individuals have been captured and only one mortality has been recorded. This research will continue through at least 2017.

Atlantic sturgeon

The MDMR, in collaboration with scientists at UM and others, proposes to conduct studies on the Atlantic sturgeon population in the GOM DPS. The directed take of Atlantic sturgeon as a result of this work is authorized through a scientific research permit (NMFS No. 16526). The proposed research will include determining movement patterns and rate of exchange between coastal river systems, characterizing the population structure (i.e., sex ratios and aging), and generating estimates of population abundance. The proposed action would involve several major river systems in Maine, including the Penobscot, Kennebec, Androscoggin and Sheepscot rivers. Smaller coastal rivers throughout Maine would also be targeted. Permit 16526 authorizes the capture up to 975 juvenile and adult Atlantic sturgeon by gill net, and the capture and mortality of 200 early life stage (ELS) Atlantic sturgeon (eggs and larvae) annually. Atlantic sturgeon captured by gill nets, trammel nets, trawls, and beach seines would be measured, weighed, photographed, PIT tagged, Floy/T-bar tagged, tissue sampled, boroscoped, apical spine sampled, blood sampled, anesthetized, fin ray sectioned, and implanted with an acoustic telemetry tag. The applicant would use MS-222 as an anesthetic or on occasion, electronarcosis; see the application for further details. Not all Atlantic sturgeon would undergo all procedures. In total, up to 200 ELS, plus two annual incidental mortalities of juvenile Atlantic sturgeon and up to one adult Atlantic sturgeon over the life of the permit would be anticipated as the result of research. This research would take place concurrently with authorized shortnose sturgeon research conducted in the Penobscot River under current Permit No. 1595. A Biological Opinion issued on the effects of this action concluded that the proposed activities were not likely to jeopardize the continued existence of any species listed by NMFS.

4.3. Other Federally Authorized Activities in the Action Area

We have completed several informal consultations on effects of in-water construction activities in the Penobscot River permitted by the ACOE. This includes several dock, pier, and bank stabilization and dredging projects. No interactions with Atlantic salmon, shortnose or Atlantic sturgeon have been reported in association with any of these projects.

4.4. State or Private Activities in the Action Area

Information on the number of sturgeon captured or killed in state fisheries is extremely limited and as such, efforts are currently underway to obtain more information on the numbers of sturgeon captured and killed in state water fisheries. We are currently working with the Atlantic States Marine Fisheries Commission (ASMFC) and the coastal states to assess the impacts of state authorized fisheries on sturgeon. We anticipate that some states are likely to apply for ESA section 10(a)(1)(B) Incidental Take Permits to cover their fisheries; however, to date, no applications have been submitted.

It has been estimated that approximately 20 shortnose sturgeon were killed each year when commercial shad fisheries were operating in several rivers in the Northeast (NMFS 1998), but there are no longer commercial shad fisheries operating in the Penobscot River.

In 2007, the MDMR authorized a limited catch-and-release fall fishery (September 15 to October 15) for Atlantic salmon in the Penobscot River upstream of the former Bangor Dam. The fishery was closed prior to the 2009 season. There is no indication that the fishery will be reinstated in the future.

4.5. Impacts of Other Human Activities in the Action Area

Other human activities that may affect listed species and critical habitat include direct and indirect modification of habitat due to hydroelectric facilities and the introduction of pollutants from paper mills, sewers, and other industrial sources. Pollution has been a major problem for this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons).

Hydroelectric facilities can alter the river's natural flow pattern and temperatures. In addition, the release of silt and other fine river sediments during dam maintenance can be deposited in sensitive spawning habitat nearby. These facilities also act as barriers to normal upstream and downstream movements, and block access to important habitats. Passage through these facilities may result in the mortality of downstream migrants.

5. CLIMATE CHANGE

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

5.1. Background Information on Global climate change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 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. 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^{o}-5^{o}C (5^{o}-9^{o}F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2^{o}C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene *et al.* 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene *et al.* 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene *et al.* 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the 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 unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2^{o}C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

5.2. Species Specific Information on Anticipated Climate Change Effects

5.2.1. Anticipated 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, predator risks, and/or thermal stress (Friedland 1998). Since the highest mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater *et al.* 2003). Temperature influences the length of egg incubation periods for salmonids (Elliot *et al*. 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

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

The productivity and feeding conditions in Atlantic salmon's overwintering regions in the ocean are critical in determining the final weight of individual salmon and whether they have sufficient energy to migrate upriver to spawn (Lehodey *et al*. 2006). Survival is inversely related to body size in pelagic fishes, and temperature has a direct effect on growth that will affect growth-related sources of mortality in post-smolts (Friedland 1998). 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 degrees Celsius), which could affect an individual's ability to access suitable spawning habitat. In addition, elevated temperatures will make some areas unsuitable for spawning and rearing due to effects to egg and embryo development.

5.2.2. *Shortnose sturgeon*

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

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

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

5.2.3. *Atlantic sturgeon*

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

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

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

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Penobscot River watershed largely focus on effects that rising water levels may have on the human environment or landscape level changes (see UMass Assessment of Landscape Changes). Available information is summarized in Jacobson *et al.* 2009. This report indicates that for Maine, regional sea surface temperatures have increased almost 2° Fahrenheit since 1970 (as measured in Boothbay), and the rate of sea-level rise has intensified. Tide-gauge records in Portland, Maine, show a local relative sea-level rise of approximately eight inches since 1912. Earlier snowmelt, peak river flows, and ice-out have been observed in Maine lakes. Models suggest that in the future temperatures will be warmer and there will be more precipitation in all seasons.

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

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

Sea surface temperatures have fluctuated around a mean for much of the past century, as measured by continuous 100+ year records at Woods Hole (Mass.), and Boothbay Harbor (Maine) and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the

North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing; for example, Boothbay Harbor's temperature has increased by about 1°C since 1970. For marine waters, the model projections are for an increase of somewhere between 3-4°C by 2100 and a pH drop of 0.3-0.4 units by 2100 (Frumhoff *et al.* 2007). Assuming that these predictions also apply to the action area, one could anticipate similar conditions in the action area over that same time period; considering that the proposed action will occur within the next three years, we could predict an increase in ambient water temperatures of 0.034-0.045 per year for an overall increase of 0.10-0.13°C.

5.3. Effects of Climate Change in the Action Area to listed species

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose and Atlantic sturgeon and Atlantic salmon. However, the short time period over which the proposed actions will occur suggests that there are not likely to be major climate related changes experienced.

Over time, the most likely effect to shortnose and Atlantic sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north which would restrict the range of juvenile sturgeon and may affect the development of these life stages. Upstream shifts in spawning or rearing habitat in the Penobscot River are limited by the existence of the Veazie Dam which is impassable by sturgeon. The proposed project will improve the situation by removing the dam, which should minimize the effects of upstream shifts in the salt wedge.
In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations through the area as sturgeon and salmon make seasonal movements. For sturgeon, there could be shifts in the timing of spawning; presumably, if water temperatures warm earlier in the spring, and water temperature is a primary spawning cue, spawning migrations and spawning events could occur earlier in the year. However, because spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of sturgeon through the action area. For salmon, there could be shifts in the timing of downstream movements by smolts or shifts in the timing of returns to the river by adults. However, during the three year time period considered here, major shifts in seasonal migrations due to climate change are unlikely given the relatively slow rate of predicted climate change.

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

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

A predicted increase in water temperature of 3-4°C within 100 years is expected to result in temperatures approaching the preferred temperature of shortnose and Atlantic sturgeon (28°C) on more days and/or in larger areas. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters.

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

6. EFFECTS OF THE ACTION

This section of the 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). This Opinion examines the likely effects (direct and indirect) of the proposed action on Atlantic and shortnose sturgeon, and Atlantic salmon in the action area and their habitat within the context of each species' current status, the environmental baseline and cumulative effects. This Opinion also examines the likely effects (direct and indirect) of the proposed action on critical habitat designated for the GOM DPS of Atlantic salmon.

The Lower Penobscot River Multi-party Settlement Agreement (MPA) included the removal of the Great Works and Veazie Dams, the construction of a fish bypass at Howland, as well as upgrades (including improved fish passage facilities and increases in power generation) at the Stillwater, Orono, Milford, West Enfield, and Medway Projects. Although the power upgrades were contemplated in the MPA, they were not a requirement of Black Bear Hydro and therefore not a requirement of the MPA; thus, they have independent utility apart from the proposed action and, thus, are not interdependent or interrelated activities. The FERC's license amendments for these other hydroelectric projects were considered in an Opinion issued by NMFS on August 31, 2012.

Effects to Atlantic salmon and its designated critical habitat, as well as to shortnose sturgeon, were addressed in the Opinion we issued in December of 2009. New information has become available since that issuance which affects our analysis and, therefore, it has been incorporated in the discussion below.

The purpose of the Trust's proposed project is to restore migratory access and habitat for multiple species of diadromous fish in the Penobscot River, including shortnose sturgeon, the GOM DPS of Atlantic salmon, and the GOM DPS of Atlantic sturgeon. To accomplish these goals, the Trust has removed the Great Works dam and proposes to remove the Veazie Projects and build a nature-like fishway at the Howland Project. These activities will affect listed salmon and sturgeon in the action area. In addition, the Trust intends to generate funds for project implementation by operating the Veazie and Howland hydroelectric facilities prior to removal. Although the removal of the Great Works Project was part of the original proposed action, it has already been removed and, therefore, effects will not be considered as part of this Opinion. It is presently unknown how long the Trust will need to operate the Veazie and Howland Projects prior to completing restoration activities. For purposes of this Opinion, however, we assume that interim operations at the Veazie and Howland Projects will occur for no longer than three years following the issuance of this Opinion. The sections that follow present our analysis of the following: (1) interim operations prior to the dam removal and bypass construction; (2) work associated with dam removal; (3) effects of the construction and operation of the Howland bypass; and (4) effects to Atlantic salmon, Atlantic sturgeon and shortnose sturgeon following dam removal and bypass construction.

6.1. Effects of Interim Operations

Hydroelectric dams can impact anadromous species through habitat alteration, fish passage delays, entrainment in turbines and impingement on screens and/or racks. Currently, the Veazie and Howland Projects are operated by the Trust pursuant to the terms and conditions of existing FERC licenses. Existing FERC license articles require the Veazie and Howland projects to be operated in a run-of-river mode with minimal impoundment fluctuations. To protect downstream migrating Atlantic salmon smolts and kelts, the Trust proposes to shut down the turbines at the Veazie and Howland Projects at nighttime for two weeks every spring throughout the interim operating period.

6.1.1. Upstream Fish Passage

This section will analyze the effects to Atlantic sturgeon, shortnose sturgeon, and Atlantic salmon attempting to migrate upstream of the projects during the interim operation period. Upstream fishways currently exist at the Veazie and Howland Projects. These fishways will continue to be operated and maintained by the Trust until the removal of the Veazie Dam and the completion of the fish bypass at Howland. The continued operation of these projects with existing fishways will affect Atlantic salmon by reducing passage efficiency above the dams and by creating migratory delays. The continued operation of these projects during the interim period will continue to preclude shortnose and Atlantic sturgeon from accessing habitat upstream of the Veazie Dam.

Atlantic and Shortnose Sturgeon

As explained above, the Veazie Dam represents the first barrier to upstream migration to sturgeon in the Penobscot River. Atlantic or shortnose sturgeon are not known to utilize existing fishways in the Penobscot River, including the fishway at Veazie Dam. As such, the continued operation of the Veazie project during the interim operation period will continue to preclude sturgeon from accessing habitat upstream of the Veazie Dam. Historically, both shortnose sturgeon and Atlantic sturgeon inhabited the Penobscot River and were present at least as far upstream as the falls near Milford as revealed by archaeological evidence (Knight 1985, Petersen and Sanger 1986), written historical accounts (Holyoke 1870, Godfrey 1882, Westbrook 1897), fishery landing data (e.g., Squiers and Smith 1979, Fernandes 2008), and annual reports of the state of Maine’s sea and shore fisheries from 1869 to 1968. It is believed that prior to dam construction, if sturgeon were able to pass the falls at Milford, they could potentially move upstream as far as Mattaseunk (rkm 171). The Veazie and Great Works Dams have effectively prevented Atlantic and shortnose sturgeon from accessing habitat upstream of rkm 47 and rkm 54, respectively. Since historical data on sturgeon specific habitat use in the river is lacking, we assume that both species sturgeon in the Penobscot River have migration patterns and habitat uses consistent with other northeastern rivers. As such, spawning was likely to occur at the most upstream accessible area, which in the Penobscot is thought to be Milford Falls (rkm 70). In many rivers, shortnose sturgeon have two overwintering concentration areas, with an upstream site closest to the spawning grounds used by pre-spawners and a more downstream site used by non-spawning adults and juveniles. Juvenile shortnose sturgeon are typically concentrated in the area above the freshwater-saltwater interface, which prior to dam construction occurred above the Veazie Dam. The interim operation of the Veazie facility will continue to preclude access to these historic habitats and will restrict the range of shortnose sturgeon in the Penobscot River. As the Howland Dam is located upstream of the presumed historic upstream limit of shortnose and Atlantic sturgeon (i.e., Milford) the Howland Dam is not thought to preclude access to historical habitats.

No sturgeon have ever been documented in the fish passage facilities at Veazie. As such, it is presumed that any attempts to migrate upstream of the Veazie Dam are precluded by a lack of suitable fish passage facilities and that no upstream passage of Atlantic or shortnose sturgeon will occur in the interim operation period. This assumption is reasonable as sturgeon have only rarely been documented to attempt to use fishways (other than fish lifts). In the Northeast U.S., the only documented occurrence of a sturgeon using a fish ladder is at the Westfield River, a tributary to the Connecticut River, which hosts a substantially smaller population of shortnose sturgeon than the Hudson River. During the summer of 2007, a shortnose sturgeon was observed swimming near the base of the ladder. Approximately 48 hours later the fish was observed in the fish trap at the top of the ladder.

As little information is available on historical habitat preferences of the species in the river, it is difficult to assess the impacts of an additional three years of restricted access from habitats upstream of Veazie Dam. However, based on migration patterns of sturgeon in other river systems it is reasonable to expect that historically they would have accessed the additional 22 rkm of habitat between Veazie and Milford falls and that this habitat would have been used for overwintering, spawning, and rearing.

It is currently unknown whether shortnose sturgeon are successfully spawning downstream of the Veazie Dam. While suitable spawning habitat has been identified, no early life stages have been documented to date. However, pre-spawning adult females (i.e., females with late stage eggs) have been captured in the river. While some of these females have been tracked moving out of the Penobscot and into the Kennebec, some of these females have remained in the Penobscot River where they presumably spawned. However, the best available information suggests that shortnose sturgeon will abandon spawning runs if ecological conditions are not suitable, and females are capable of reabsorbing eggs. This suggests that pre-spawners caught below the dam could be abandoning the spawning attempt due to a lack of suitable habitat. As evidenced above, there is considerable uncertainty regarding whether shortnose sturgeon are currently spawning in the Penobscot River. Even if some successful spawning does occur downstream of the Veazie Dam, the available spawning habitat has been truncated by the presence of the dams.

Spawning areas in most U.S. rivers have not been well defined for Atlantic sturgeon. However, the habitat characteristics of possible spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Atlantic sturgeon spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers. Spawning location is important when considered together with information from laboratory studies regarding larval drift and salinity tolerances. Theoretically, a spawning location low in the river coupled with larval drift behavior that carries larvae too far downstream would transport them to areas of harmful or fatal salinity regimes. The Veazie Dam also restricts the available nursery habitat for young sturgeon. Habitat use of young-of-year (YOY) sturgeon differs markedly from that of yearlings and older juveniles; this is believed to be a function of salinity tolerances. Little is known about YOY behavior and movements in the wild but individuals of this age are believed to remain in channel areas within freshwater habitats upstream of the salt wedge for about one year (Dadswell *et al*. 1984, Kynard 1997). Jenkins *et al*. (1993) found that salinity tolerances of young Atlantic and shortnose sturgeon improve with age; individuals 76 days old suffered 100% mortality in a 96-hour test at salinities ≥15 ppt while those 330 days old tolerated salinities as high as 20 ppt for 18 hours but experienced 100% mortality at 30 ppt. Jarvis *et al*. (2001) demonstrated that 16-month old juveniles grew best at 0% salinity and poorest at 20% salinity. Other studies suggest that age-0 (i.e., young-of-year), age- 1, and age-2 juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley 1996, Munro *et al.* 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.* 2000). Lastly, Ziegeweid *et al*. (2008) demonstrated that salinity and temperature interact, affecting survival of YOY shortnose sturgeon. As salinity and temperature increased, survival decreased; however as body size increased, individuals were better able to tolerate higher temperatures and salinities (Ziegeweid *et al*. 2008). The Veazie Dam severely limits the amount of low salinity habitat that young sturgeon can access. This limited reach of freshwater negatively impacts the viability of early life stages of sturgeon and may contribute to high levels of mortality for larval and young of the year.

The interim operation of the Veazie Project over the next three years will continue to prevent Atlantic and shortnose sturgeon from accessing historic spawning and rearing habitat. Without an accurate estimate of the number of sturgeon in the Penobscot River, it is difficult to quantify the number of sturgeon that will be affected by interim operations of the project. However, based on population dynamics in other river systems, approximately one-half of adult males and one-third of adult females are likely to spawn in a given year. Over the two year interim operation period, nearly all adult Atlantic and shortnose sturgeon in the Penobscot River are likely to normally attempt to spawn and will be affected by the lack of available habitat. All larvae and YOY produced by these spawning adults will be affected by limited access to freshwater habitat where viability is expected to be greatest.

Additional effects to sturgeon from the interim operation of the Veazie Dam include the effects of operations on flow and water quality downstream of the project. The project is expected to continue to operate in run- of- river mode, thereby eliminating the current impoundment, and lowering water levels by 3- 4.5 meters. The dam structure and interim operations will continue to alter habitat conditions below the dam. Effects to sturgeon species from dam operations are currently unknown; however, to the extent that interim operations alter water depth or velocity, interim operations could affect successful sturgeon spawning and development of early life stages. Similarly, as one of the triggers for movement to the spawning grounds is thought to be decreases in flow following spring runoff, combined with warming water temperatures, to the extent that interim run- of- river operations affect normal spring flow conditions in the river, spawning of Atlantic and shortnose sturgeon is likely to be affected.

Atlantic Salmon

Atlantic salmon are known to successfully utilize upstream fishways at the Veazie and Howland Projects. However, neither of the fishways are 100% effective at passing Atlantic salmon. As described above, at Veazie Dam upstream passage success ranged from 44% in 1990 to 89% in 1992, with a pooled passage rate 68% (63 of 93) over five years of study using Carlin and radio tags (Shepard 1995). Similarly, a three year study that was conducted between 2002 and 2004 that looked at migratory movements of adult Atlantic salmon using PIT tags indicated passage success at Veazie ranging between 70% and 100% (Beland and Gorsky 2004, MASC unpublished data). In 2005 and 2006, Holbrook *et al.* (2009) conducted acoustic telemetry studies to assess upstream passage of adult salmon in the Penobscot River from the Veazie Dam upstream to the Howland and West Enfield Dams. Passage at Veazie was 50% in 2005 (2 of 4) and 43% in 2006 (3 of 7). Based on all of these studies, Holbrook *et al.* (2009) calculated that passage at the Veazie Project ranged between 43% and 100%, with a median passage rate of 64%.

Passage success of adult Atlantic salmon is less understood at the Howland Project. This is because adult salmon reaching this area of the Penobscot River can either attempt to enter the Piscataquis River or continue migrating up the mainstem Penobscot River. Beland and Gorsky (2004) reported successful use of the Howland fishway by adult Atlantic salmon. Beland and Gorsky (2004) also reported a salmon dropping downstream after using the Howland fishway. Based upon radio telemetry studies conducted from 1989-1992, Shepard (1995) estimated pooled upstream passage rates for adult Atlantic salmon at the Howland and West Enfield from 88-89%. Therefore, it is believed that the Howland Project fishway is at least 88% effective at passing adult Atlantic salmon that are homing to the Piscataquis River. However, delays experienced by salmon using the fishway could be having some negative effects on reproduction.

In addition to documenting passage success, past studies at Veazie and Great Works have documented delays in upstream migrations for Atlantic salmon. The yearly pooled median passage time at Veazie Dam ranged from 4.7 days to 33.2 days over five years of study, while the total range of individual passage times over this study period was 0.5 days to 99.5 days (Shepard 1995). Passage delays at Great Works were substantially less than that observed at Veazie. At Great Works, the year-specific median passage time ranged from 1.4 to 2.7 days over four years of study, while the total range of individual smolt passage times over the entire study period was 0.3 days to 30.4 days (Shepard 1995). Potential passage delay at the Howland Project is less understood.

Adult salmon that are not passed at the Veazie and Howland Projects 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 at the Veazie and Howland Projects. Although no studies have looked directly at the fate of fish that fail to pass through upstream fish passage facilities on the Penobscot River, we convened an expert panel in 2010 to provide the best available information on the fate of these fish. 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). Dams that do not have fishways were not considered by the expert panel to have baseline mortality. Additional mortality was assumed based on project specific factors, such as predation, fish handling, high fall back rates, lack of thermal refugia, etc. The panel assumed an additional 1% mortality at the Veazie Project due to handling associated with the trapping and handling facilities, and an additional 1% due to high levels of seal predation. Therefore, it is estimated that 3% of salmon that fail to pass the Veazie Project are killed every year. Likewise, the panel assumed an additional 1% mortality at the Howland Project due to high levels of fallback. Therefore, it is estimated that 2% of salmon that fail to pass the Howland Project are killed every year. The proposed project will eliminate this source of mortality, but it is expected to persist until the Veazie Dam is removed and the bypass is constructed around Howland.

6.1.2. *Downstream Fish Passage*

The Veazie and Howland Dams both operate with some form of downstream fish passage and protection, including reduced spacing of the trashracks for protection against turbine entrainment and sluice gates or other openings for downstream passage (Trust 2008). These fishways will continue to be operated and maintained by the Trust until dam removal activities are ready to commence. Since none of the fishways are 100% effective at preventing turbine entrainment and impingement of Atlantic salmon and migratory delays are expected at each dam, continuing to operate the Veazie and Howland Projects will affect downstream movements of Atlantic salmon in the Penobscot River watershed. Neither sturgeon species will be affected by operation of downstream fishways since they do not occur upstream of any of these dams and therefore do not use any downstream fishways.

Downstream migration of post-spawned Atlantic salmon adults (kelts) and smolts occurs primarily in April and May. Typically, high spring flows resulting from snow melt creates spillage over the spillways of the Veazie and Howland Projects. Flow duration curves for each project demonstrate that on average during April and May, spillage occurs 90% of the time at Veazie, and 45-70% of the time at Howland. Studies have shown that spill conditions generally enhance downstream passage for kelts and smolts in the Penobscot (Shepard 1988, Hall and Shepard 1990, Shepard 1991, Holbrook 2007). The greatest risk for downstream migrating salmon occurs when spring runoff is unusually low resulting in no spillage at the dams. This results in fish having to rely on downstream fish passage facilities, which are not 100% effective, or having to pass through the turbines, which can result in injury or mortality (Holbrook 2007).

Estimates of downstream passage efficiency and smolt survival for projects in the Penobscot vary widely depending on operational and environmental conditions. In 1989, net smolt survival over the three lower river mainstem dams (Milford, Great Works, Veazie) and the intervening habitat was between 30.5% and 61% (Shepard 1991). Smolt studies conducted by Holbrook (2007) documented significant losses of smolts in the vicinity of mainstem dams in the Penobscot River. Of the 355 radio tagged smolts released in 2005, 43% were lost in the vicinity of the West Enfield, Howland, and Milford Dams. In 2006, 60% of tagged smolts (n=291) were lost in the vicinity of the West Enfield, Howland, and Milford Dams.

Estimates of downstream passage efficiency and survival for smolts and kelts through all of the dams on the Penobscot have been modeled by Alden Lab (2012) (Tables 3 and 4). Survival rates were calculated for the range of possible flow conditions. Mean smolt survival rates at Veazie and Howland, respectively, were 89.7% and 91.5%, with minimum survival rates 82.7% and 89.6%.

Through the three months of outmigration (April, May, November), Alden (2012) indicates that monthly mean survival rates of kelts at Veazie range between 80.8% and 85.0%, while the mean minimum survival rate ranges between 71.8% and 80.6%. Monthly mean kelt survival at the Howland Project ranges between 92.6% and 92.9%, while the minimum survival rate ranges between 92.3% and 92.4%. If these values are weighted based on 80% of migration occurring in the spring (Lévesque *et al.* 1985, Baum 1997), an overall mean survival of kelts at Veazie can be estimated as 83.2%, with a minimum overall survival of 75.3%. Likewise, the overall mean survival at kelts at Howland can be estimated as 92.7%, with a minimum overall survival of 92.3%

The potential for delays in the timely passage of smolts encountering the Veazie and Howland Projects is also evident in past studies. Shepard (1991) documented delays in excess of 5 hours for 17% smolts encountering the Milford Project, and 15% encountering the Veazie Project.

Downstream passage of kelts in the Penobscot River was assessed using radio telemetry techniques during a study in 1988 (Shepard 1989b). Equipment malfunctions during the study limit data interpretation; however, it was apparent the kelts relied on spillage flows to migrate past the Milford and Veazie Dams during the study. In fact, some kelts spent hours to days searching for spillway flows to complete their downstream migration.

To protect downstream migrating smolts and kelts during interim operations, the Trust is proposing to reduce generation at the Veazie and Howland Projects during the peak of the downstream migration period. Reduced generation will result in increased spillage at each facility thus decreasing the occurrence of turbine entrainment and impingement. Specifically, the Trust is proposing to shut down all but one turbine at each dam from 8:00 pm to 4:00 am daily from May 7 to May 20 during the interim operation period to protect downstream migrants. Based on unpublished data from NMFS collected between 2000 and 2005, smolt migration substantially begins when water temperatures reach approximately 10°C. Water temperature data collected at the USGS Eddington stream flow gage from 1979 to 2009 indicate that ambient temperatures in the Penobscot River typically reach 10°C by May 7th annually. Once temperatures reach 10°C, approximately 75% of the smolts migrate out of the Penobscot River in a two week period (NMFS unpublished data). Similarly, the bulk of the downstream smolt movement has been shown to occur between sunset and sunrise (Kocik *et al*. 2009, Shepard 1991). The Trust has determined that one generating unit must continue to operate at each of the three projects during the shutdown period in order to facilitate start-up procedures and provide for station power.

Given the measures implemented by the Trust to minimize mortality during interim operations, it is expected that the minimum survival rates calculated by Alden (2012) are conservative estimates of what would be expected at the Veazie and Howland Projects. Therefore, it is expected that no more than 17.3% and 10.4% of smolts will be killed annually at the Veazie and Howland Projects, respectively, due to the direct and indirect effects associated with dam passage over the next three years. Given the night time turbine shutdowns, this level of mortality is expected to only occur for two weeks or so. During the two weeks of the turbine shutdowns, mortality would be significantly less. Likewise, it is anticipated that no more than 24.7% and 7.7% of kelts will be killed at the Veazie and Howland Projects, respectively, during interim operations.

6.1.3. *Atlantic Salmon Critical Habitat*

As discussed in Section 3, critical habitat for Atlantic salmon has been designated in the

Penobscot River including the sections of river in the vicinity of the Veazie and Howland Projects. 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 analysis presented in 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 expect that the proposed interim operation period would continue to harm these already impaired habitat characteristics, or retard progress toward attaining properly functioning condition during the interim operating period. Thus, we expect interim operations to cause temporary adverse effects to some essential features of critical habitat, including water quality, substrate, migration conditions, and forage in a similar manner as present in the environmental baseline. However, we expect the effects of the Veazie Dam removal to be temporary, ceasing upon removal of the project; and the effect of the Howland Dam to be reduced by the construction of the fish bypass. The effects summary of the interim operations on critical habitat for the environmental baseline would also represent impacts on critical habitat during interim operations at the Veazie and Howland Projects (Table 8).

Table 8. Atlantic salmon critical habitat essential features following removal of the Veazie Dam and the construction of a fish bypass at the Howland Dam.

Pathway/Indicator	**Life Stages Affected**	**PCEs Affected**	**Effect**	**Population Viability Attributes Affected**
Passage/Access to Historical Habitat	Adult, juvenile, smolt	Freshwater migration	Unimpeded upstream passage will eliminate delays to spawning habitat. Unimpeded downstream passage will eliminate 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	Removing Veazie impoundment will restore spawning and rearing habitat, decrease predation, increase productivity, and facilitate migrations. Installing nature-like fishway at Howland will create suitable	Adult abundance and productivity Juvenile growth rate

			rearing habitat.	
Water Quality	Adult, juvenile, incubating eggs	Freshwater spawning and rearing	Removing Veazie impoundment will improve water quality (temperature and dissolved oxygen) for spawning and rearing habitat.	Adult abundance and productivity Juvenile growth rate

6.2. **Effects of Veazie Dam Removal**

The potential effects associated with the dam removal projects include inhibiting fish passage during construction, increasing suspended sediment (and resulting deposition), causing direct injury and mortality during construction, and potentially spilling toxic substances (e.g., equipment leaks).

Effects of Veazie Dam removal related to in-water work are likely to be restricted to the area between the old Bangor Dam and the base of the Veazie Dam. The approximate river distance between the former Bangor dam and the Veazie Dam is approximately five river kilometers (rkm); the river surface area between them is approximately one square kilometer.

As explained in the “Description of the Action” section above, removal of the Veazie Dam will occur in several phases. Phase I will not involve any in-water work, with the exception of the installation of the downstream debris boom which will float on the surface and serve to trap any floating debris. In-river work to be carried out in subsequent phases will largely be limited to construction of several access roads (temporary causeways) and the removal of dam segments with heavy equipment staged from these access roads. With the exception of the east bank access road to be installed during Phase V (upstream structure removal), the installation of the temporary access roads will largely occur in the dry. Similarly, as the access roads will serve to divert water away from the work site, dam removal activities staged from these access roads will also occur largely in the dry. Dam removal activities will affect water quality and fish passage. Effects to Atlantic sturgeon, shortnose sturgeon, and Atlantic salmon as well as effects to designated Atlantic salmon critical habitat are detailed below.

6.2.1. *Water Quality*

Sediments and Turbidity

Removal of the Veazie Dam and associated structures will require the extensive use of heavy equipment in the Penobscot River. Construction activities associated with dam removal activities including spillway removal, powerhouse removal, and building and removing access roads, etc. will temporarily introduce sediment and increase turbidity in the Penobscot River. While the Trust will employ state-of-the-art procedures to prevent and minimize erosion and sedimentation during construction as is described in the FERC's BA, some release of fine materials and turbidity is likely to occur as a result of access road construction and dam demolition.

Any sediment accumulated in the impoundment of each project is also likely to be mobilized and released to downstream areas following dam removal. Based on sediment, shoreline, and bathymetric surveys conducted in 2007, post dam removal erosion has not been identified as a significant concern. Substrates in the Veazie impoundment are dominated by cobble, boulder, and bedrock (95% of all substrates), which limits the potential for erosion and sediment transport. Sediment accumulation in the Veazie impoundment is small (15,291 to 44,344 cubic meters), with most of it located along the western shoreline and removed from the location of the dam. The majority of the sediment located upstream of the dams will be exposed and dry following dam breach, and therefore will not be subject to riverine transport. Thus, the breaching of the dams is not expected to release significant levels of accumulated sediments into the river. Any erosion that does occur as a result of removing the dams will primarily be associated with areas adjacent to or near the former dam site, where the water surface elevation will change the most and where the banks are steepest. However, since the construction work would be done in phases, each of which would be initiated after steps have been taken to control water flows at the dam site, erosion and sediment releases at the dam should be minimal.

Elevated total suspended solids (TSS) concentrations have the potential to adversely affect adult and juvenile Atlantic salmon, and Atlantic and shortnose sturgeon in the Penobscot River. 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 580mg/L to 700,000mg/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, Newcomb and Jensen (1996) concluded that more than six days exposure to total suspended solids (TSS) greater than 10 mg/l 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). 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 re-deposited 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.

State fishery agencies recently estimated juvenile Atlantic salmon production in the Penobscot watershed, using habitat surveys and suitability modeling (MDMR 2009, MDIFW 2009). According to the model, there are 9,822 rearing units (each rearing unit consists of 100 square meters) identified in the reach of the Penobscot River between Milford and Veazie. However, the state’s modeling estimated zero production of salmon parr for this reach. This is likely due to the fact that parr production is highest in smaller streams in the Penobscot watershed (less than 12 meters wide) and becomes negligible in river segments wider than 100 meters due to factors such as increased water temperatures and biological community composition (MDMR 2009, MDIFW 2009).

Given that accumulated sediments are limited in the Veazie impoundment and BMPs for erosion and sedimentation control will be employed throughout construction activities and no Atlantic salmon parr are expected to occur downstream of the Veazie Project, we do not expect any Atlantic salmon mortalities from elevated TSS or sediments during construction activities. Atlantic salmon are likely to experience behavioral avoidance of turbid waters during dam removal activities. It is unlikely that any significant number of parr would be present below the project during construction activities since the area is not stocked with fry or parr and natural reproduction in these areas is not known to occur. Atlantic salmon adults experiencing elevated TSS levels are likely to relocate to downstream areas until conditions improve to resume their upstream migration.

Sturgeon species are generally more tolerant of elevated TSS levels than salmonids. While there have been no directed studies on the effects of TSS on Atlantic or shortnose sturgeon, juveniles and adults are often documented in turbid water. Dadswell *et al. (*1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, shortnose and Atlantic sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass. Studies with striped bass adults have shown that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser 1976, Combs 1979 *in* Burton 1993). Striped bass showed some adverse blood chemistry effects after 8 hours of exposure to TSS levels of 336mg/l (Normandeau 2001).

The life stages of sturgeon most vulnerable to increased sediment are eggs and larvae which are subject to burial and suffocation. As noted above, no eggs and/or larvae will be present in the action area. Juvenile and adult sturgeon are frequently found in turbid water and would be capable of avoiding any sediment plume by swimming higher in the water column. Laboratory studies (Niklitschek 2001, Secor and Niklitschek 2001) have demonstrated shortnose sturgeon are able to actively avoid areas with unfavorable water quality conditions and that they will seek out more favorable conditions when available. While the increase in suspended sediments may cause shortnose sturgeon to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movement further up in the water column or further downstream in the river. Based on this information, any increase in suspended sediment is not likely to affect the movement of Atlantic or shortnose sturgeon between foraging areas and/or concentration areas during dam removal or otherwise negatively affect sturgeon in the action area. As neither sturgeon species occur in the vicinity of the Howland Dam, effects from turbidity and suspended sediment will be limited to the area below Veazie.

Contaminants

Use of heavy equipment in or near a water body introduces the risk that toxic contaminants (e.g., fuel, oil, etc.) could enter the Penobscot River. Chemical contaminants can be introduced into waterbodies through direct contact with contaminated surfaces or by the introduction of storm or washwater runoff and can remain in solution in the water column or deposit on the existing bed material. Research has shown that exposure to contaminants can reduce reproductive capacity, growth rates, and resistance to disease, and may lead to lower survival rates for salmon (Arkoosh 1998a, 1998b). The risk for contaminants entering the Penobscot River would increase during construction, possibly degrading habitat condition.

To reduce the potential for introducing contaminants into the river during construction activities, the Trust will require the contractor to follow several best management practices (BMPSs) including: a) no equipment, materials, or machinery shall be stored, cleaned, fueled or repaired within any wetland or watercourse; b) dumping of oil or other deleterious materials on the ground will be forbidden; c) the contractor shall provide a means of catching, retaining, and properly disposing of drained oil, removed oil filters, or other deleterious material; and d) all oil spills shall be reported immediately to the appropriate regulatory body. These BMPs will reduce the likelihood of any contaminant releases into the river during construction activities. Based on implementation of this plan, it is extremely unlikely that there would be a release of contaminants into the river. As such, any effects to listed species as a result of contaminants from heavy equipment in the action area would be discountable.

Sediment cores taken from the Veazie Project were analyzed by the Trust for multiple contaminants including PCBs, volatile organic compounds, semi-volatile organic compounds, dioxins and furans, and inorganic metals. A number of Semi-Volatile Organic Compounds (SVOC) including pyrene, phenanthrene, flouranthene, and chrysene were detected in the sediment cores. Pyrene, phenanthrene, flouranthene, and chrysene are classified as Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are created when products like coal, oil, gas, and garbage are burned but the burning process is not complete. The entire Penobscot River estuary has been identified by the MDEP as impaired by mercury from industrial point sources and Combined Sewer Overflows (MDEP 2004).

The majority of inorganic and organic compounds analyzed by the Trust were below informal sediment quality guidelines established by NOAA (1999). Limited contamination of sediments in the project areas may be due, in part, to the lack of fine sediments. However, two heavy metals (silver and nickel) detected in sediment samples taken at the projects did exceed identified criteria in the NOAA guidance. Metals such as silver and nickel can be toxic to fish, affecting growth, metabolism, respiration, reproduction, and numerous other biological functions (Nehlson *et al*. 1991).

It is difficult to predict the concentrations of contaminants that would be mobilized into the water column during dam removal operations. The US Environmental Protection Agency (EPA) has set both Criteria Maximum Concentration (CMC) or acute criteria defined as the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (one - four hours) without deleterious effects) and Criteria Chronic Concentration (CCC) or chronic criteria defined as the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (four days) with deleterious effects) for priority toxic pollutants in freshwater and saltwater. CMC and CCC limits for nickel in freshwater have been established at 470 µg/l and 52 µg/l, respectively. CMC limits for silver in freshwater have been established at 3.4 µg/l. CCC limits have not been established by EPA for silver in freshwater. Based upon the small amount of contaminated sediment likely to be disturbed and the high flushing rates in the Penobscot River, nickel and silver concentrations are not expected to exceed the aquatic life criteria set by EPA for these metals. While information specific to effects of exposure of nickel and silver on Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon is not available, as EPA's aquatic life criteria are designed to be protective of the most sensitive species, it is reasonable to expect that these criteria would also be protective of Atlantic and shortnose sturgeon as well as Atlantic salmon. As such, the re-suspension of sediments contaminated with nickel and silver in concentrations less than EPA's aquatic life criteria, are likely to have only insignificant effects on Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon.

6.2.2. *Fish Passage*

Activities associated with the removal of the Veazie Project have the potential to affect upstream and downstream migrations of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon in the lower Penobscot River.

As explained above, Atlantic and shortnose sturgeon do not use the fish passage facilities at the Veazie Dam. If sturgeon species are spawning below the base of the Veazie Dam, in-water activity during the spawning season could disrupt spawning and affect movement of individuals to the spawning grounds and on the spawning grounds. However, as sturgeon spawning will be completed at the time of dam removal activities, movements of spawning adults are not expected to be affected. Therefore, only passage of upstream migrating Atlantic salmon adults could be affected by the Veazie Dam removal activities.

Removal of the Veazie Dam is slated to commence July 1 in order to allow the majority of the upstream migration of salmon to occur prior to work activities. Since most adult salmon enter the Penobscot between May and mid-July (Fay *et al*. 2006), only a portion of the overall run could be delayed by removal work at Veazie. Trap counts obtained at the Veazie Dam during 2007-2010 suggest that about 77% of the adult run of Atlantic salmon in the Penobscot River pass the Veazie Dam by July 1 annually. The Trust has indicated that creation of a suitable zone of passage at Veazie via breaching of the spillway is expected to take three to four weeks. During this three- four week period, the Veazie fishway will be inoperable. Therefore, we expect that up to 23% of the run of adult salmon in the Penobscot River could be delayed three-four weeks during the first year of dam removal activities at the Veazie Dam. Atlantic salmon delayed below the Veazie Dam could fall down to other Penobscot River tributaries to spawn, resume their upstream migration once a suitable zone of passage is created, or not complete spawning at all. It is not possible to predict the fate of individual adult salmon delayed during the four week period. However, we anticipate that some of these fish will resume their upstream migration once passage is restored or choose to spawn in downstream tributaries such as Kenduskeag Stream, Ducktrap River, or Cove Brook. Nevertheless, a three to four week delay in upstream migration would negatively affect the reproductive fitness of adult Atlantic salmon.

As discussed previously, the Trust also plans to remove the remains of a submerged dam located just upstream of the Veazie Dam. While the Trust believes that it can remove the main Veazie Dam during the first year of work, complete demolition and removal of this remnant dam may require a second construction season. It is unclear whether the remnant dam at Veazie would preclude upstream migration of adult Atlantic salmon once the main dam removed. However, given that the submerged dam is largely oriented parallel to stream flows along the east bank of the river (i.e., it does not cross the entire river), it is unlikely that the submerged dam will be a significant passage barrier to Atlantic salmon. If a passage barrier is detected, the Trust will create a suitable breach during the second construction season. Given the uncertainty whether the submerged dam will actually impede passage, we cannot predict whether impacts will actually occur to adult salmon.

Following the removal of the Veazie Dam, remnant upstream structures, including remnants of an old (currently submerged) timber crib dam will be removed. As this will occur after the Veazie Dam has been breached, sturgeon could be present in the area of the submerged dam. However, as access road construction will occur in stages and the entire river will never be blocked, a sufficient zone of passage is expected to be present at all times. As such, activities associated with the removal of the remnant dam are not expected to result in any impediment to Atlantic or shortnose sturgeon passage.

Stranding

As discussed previously, construction activities will occur between July and October, when approximately 23% of the salmon run could be expected to be migrating through the mainstem of the Penobscot River. In this timeframe, the area around the dam will be isolated by upstream and downstream access roads that will divert flow away from the construction area. Isolation or dewatering of a work area minimizes the overall adverse effects of construction activities on listed salmon and sturgeon because it reduces their exposure to in-water construction activities. However, isolating the work area could lead to negative impacts on fish if any are trapped within the dewatered work area. In addition, it is possible that Atlantic salmon could become trapped in pools upstream of the Veazie Project when the impoundment is drawn down. Likewise, both salmon and sturgeon could become stranded when a section of riverbed downstream of the powerhouse and the west end of the spillway is dewatered when river flow is diverted through the breached spillway.

The fishway will be inoperable for three to four weeks prior to the breaching of the Veazie Dam. During this timeframe it is expected that Atlantic salmon that were passed at the Project will continue their upriver migrations and, therefore, will not be in the area prior to the dewatering of the work area. However, it is possible that some individuals will hold in the area upstream of the dam due to warm water temperatures, or a lack of motivation to migrate. These fish could potentially become stranded either in the work area, or in the area that will be dewatered as the impoundment is lowered.

FERC has required that the Trust develop a salvage and relocation plan for any mussels or fish stranded during drawdown of the impoundments at the Great Works, Veazie, and Howland Projects. The plan was developed in consultation with state and federal resource agencies. To minimize the probability of stranding, drawdown will occur in phases to give fish more time to move out of these areas, and to provide adequate time for the dewatered area to be thoroughly surveyed. After the area has been dewatered, a visual survey will be conducted by qualified personnel to verify that there are no Atlantic salmon or sturgeon stranded within the project area. If any are located, they will be removed and returned to the River. The implementation of such an evacuation plan will minimize the effect so that entrapped fish would not be anticipated to be injured or killed by the construction and dewatering of the proposed cofferdams.

Capturing and handling fish causes physiological stress and can cause physical injury although these effects can be kept to a minimum through proper handling procedures. The fish evacuation plan should minimize such stresses by requiring minimal handling time; minimal time that fish are held out of the water; and using transfer containers with aerated stream water of ambient temperature. Impacts to fish will be further minimized by requiring that only qualified biologists handle the stranded fish. Given these minimization efforts, it is not expected that there will be any injury or mortality associated with cofferdam construction.

Although it is not possible to anticipate how many Atlantic salmon, shortnose sturgeon, or Atlantic sturgeon will be trapped, it is assumed that the number will be very low. As described above, Atlantic salmon that are passed into the Veazie impoundment will have had three to four weeks after the fishway becomes inoperable to migrate upstream before the dam is breached and the water levels are reduced significantly. Therefore, it is expected that few, if any, Atlantic salmon will be in the dewatered area. Based on this information, it is assumed that no more than one Atlantic salmon will be stranded as a result of the lowering of the impoundment level, or due to the diversion of river flow.

As indicated previously, the breaching of the dam will not occur until after the spawning season for shortnose sturgeon, so it is not expected that there will be any pre-spawn adults, eggs, or juveniles in the habitat immediately downstream of the project. However, adult shortnose sturgeon have been documented in the area of the river between the old Bangor Dam and the Veazie Dam in late summer. In a study conducted in 2006 and 2007 by the University of Maine, it was found that 100% of acoustically tagged shortnose sturgeon moved upriver in the summer, and by mid-July were located between rkm 24 and rkm 42. By mid August of both years, the majority of tagged fish had moved up to between rkm 32 and rkm 45 (Fernandes *et al.* 2010). However, no sturgeon moved within two kilometers of the Veazie Dam (rkm 47) in either year (Fernandes *et al.* 2010). It is likely, therefore, that only a small number of individuals could be in the area immediately downriver of the dam. It is anticipated that most of these fish will migrate through the deeper portions of the river channel and, therefore, would be less likely to become stranded in shallow areas along the banks when the water level drop. Based upon this information, it is assumed that no more than one shortnose sturgeon could become stranded in the habitat downstream of the Veazie Project when flow is diverted.

Atlantic sturgeon are less likely to be in the vicinity of the Veazie Project than shortnose sturgeon. Fernandes *et al.* (2010) monitored movements of acoustically tagged Atlantic sturgeon in 2006 and 2007 and found that in the late summer they concentrated in a deep (>15 meters) 1.5 kilometer section of the river between rkm 23 and rkm 24.5 prior to emigrating from the system. No Atlantic sturgeon were detected any further upriver than rkm 36, which is 11 kilometers downriver of the Veazie Project, and most were found further downriver. Fernandes et al. (2010) also found that Atlantic sturgeon preferred deeper water than shortnose sturgeon (average of 10.3 meters for Atlantics versus 6.4 meters for shortnose), which would suggest that they are less likely to utilize shallow habitats that could be dewatered when river flows are diverted. Given that the evidence suggests that Atlantic sturgeon do not use the habitat in the vicinity of the Veazie Project, it is not expected that any will be stranded during the proposed project.

6.2.3. *Noise*

Noise will be generated by equipment (hoe rams, excavators, etc.) required for the breach of the dams, demolition of stone masonry, concrete structures, and by vehicles operating on the temporary access roads. As the majority of the demolitions work will be conducted in the dry, Atlantic sturgeon, shortnose sturgeon, and Atlantic salmon exposure to elevated levels of underwater sound/pressure will be minimal because impulse transmission from one medium (air or water) is not easily transmitted across the air/water interface to a different medium (Akamatsu *et. al*. 2002, as referenced *in* Popper 2003).

The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, USFWS, Federal Highway Administration (FHWA), and the California, Washington and Oregon DOTs, supported by national experts on sound propagation activities that affect fish and wildlife species of concern. In June 2008, the agencies signed an MOA documenting criteria for assessing physiological effects of pile driving on fish (FHWG 2008). The criteria were developed for the acoustic levels at which physiological effects to fish could be expected. It should be noted, that these are onset of physiological effects (Stadler and Woodbury 2009), and not levels at which fish are necessarily mortally damaged. These criteria were developed to apply to all species, including listed green sturgeon and several species of salmon, which are biologically similar to shortnose and Atlantic sturgeon and Atlantic salmon, respectively, and for these purposes can be considered surrogates. The interim criteria are:

- Peak SPL: 206 decibels relative to 1 micro-Pascal (dB re 1 µPa).
- cSEL: 187 decibels relative to 1 micro-Pascal-squared second (dB re 1µPa^2-s) for fishes above 2 grams (0.07 ounces).
- cSEL: 183 dB re 1µPa^2-s for fishes below 2 grams (0.07 ounces).

At this time, these criteria represent the best available information on the thresholds at which physiological effects to sturgeon and salmon are likely to occur. It is important to note that physiological effects may range from minor injuries, from which individuals are anticipated to completely recover with no impact to fitness, to significant injuries that will lead to death. The severity of injury is related to the distance from the pile being installed and the duration of exposure. The closer to the source, and the greater the duration of the exposure, the higher the likelihood of significant injury.

The Trust has proposed to demolish the Veazie Dam using a hydraulic hoe ram, or alternatively a breaking ball or a splitting wedge repeatedly dropped by a crane. The limited amount of information available on the noise effects associated with hoe ramming suggests that the amount of peak noise produced can vary between 150 dB re 1 µPa at 15 meters from the source (FHWA 2008) and 190 dB re 1 µPa at 30 meters away from the source (Dolat 1997). NMFS (2004), in a biological opinion for a bridge replacement project that involved pier demolition with a hoe ram in California, noted that there is a ten-fold decrease in the driving energy delivered by a hoe ram as compared to a pile-driving hammer. During demolition of concrete piers in the Connecticut River, Dolat (1997) measured sound in the water from use of a hoe ram. Peak sound measurements 30 meters from the demolition of a pier without a cofferdam was 190 dB re 1 µPa and for a pier with a cofferdam was 181 dB re 1 µPa. Another set of sound measurements on either side of the cofferdam showed 187 dB re 1 µPa inside and 180 dB re 1 µPa outside of the cofferdam. As demolition of the Veazie Dam will occur in the dry, it is anticipated that noise levels will be on the lower end of this scale. As the peak noise levels expected from the use of a hoe ram in the dry are well below the FHWG thresholds, it is anticipated that no fish will be injured as a result of noise emitted during the demolition of the piers and abutment of the old bridge.

Sound Induced Behavior Modification

The FHWG has not yet provided criteria for sound levels that would affect the behavior of fish and, therefore, might be considered to cause fish to experience behavioral modifications, such as avoidance. For the purposes of this consultation we will use 150 dB re 1 µPa RMS as a conservative indicator of the noise level at which there is the potential for behavioral effects.

Noise levels exceeding 150 dB re 1 µPa RMS will not always result in behavioral modifications or that could rise to the level of "take" (i.e., harm or harassment), but there is the potential, upon exposure to noise at this level, to experience some behavioral response. Behavioral responses could range from a temporary startle to avoidance of an ensonified area. Although more research is needed, there are several studies that support this as a conservative threshold for behavioral effects. Observations by Feist *et al*. (1992) suggest sound levels greater than 150 dB may disrupt normal migratory behavior of salmon and steelhead. They observed that salmonids respond by avoiding the area of greatest sound levels and attempt to swim along the opposite side of the channel or along the shoreline furthest away from the active pile driving operation. Turnpenny *et al*. (1994) and Wysocki *et al*. (2007) documented that salmonids exposed to noise levels up to 150 dB RMS did not exhibit signs of stress. Given these studies, 150 dB RMS is a conservative estimate of what sound levels might result in behavioral modifications, such as avoidance, by listed shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon.

It is assumed that the demolition of the dam structures will create noise levels that could lead to an avoidance response in fish that are in the vicinity. For some proportion of these fish, this will affect migratory behavior past the Project. However, it is anticipated that demolition activities will not persist for more than 12 hours per 24 hour period, so it is not expected that any individual fish will be affected for more than 12-hours at a time. A temporary blockage of migration for no more than 12-hours would not impair the ability of a fish to complete any normal behaviors, such as migration, foraging, spawning or overwintering and, as such, the effects of temporary exposure to underwater noise greater than 150 dB will be insignificant.

6.2.4. *Atlantic salmon Critical Habitat*

Proposed construction activities will temporarily reduce the status of several habitat indicators relative to Atlantic salmon critical habitat. We expect these activities to cause temporary adverse effects to the migratory PCE of critical habitat by reducing water quality due to increased noise and turbidity and the filling of habitat. Construction has been timed so that in-water effects to the habitat (turbidity, noise and the presence of temporary fill) will not coincide with the smolt outmigration period. However, construction effects may still reduce the functioning of the habitat for adult Atlantic salmon in the mainstem for short intervals.

The demolition of the Veazie Dam will require the placement of a significant amount of temporary fill below the ordinary high water (OHW) line in the Penobscot River. The entirety of the temporary fill will be placed and removed outside of the spring outmigration period. In addition, the lowering of the impoundment will affect migration habitat by making the fishway inoperable for a period of three to four weeks. Therefore, activities associated with the dam removal will lead to significant, but temporary, effect on the migration PCE. Upon completion of dam removal, overall habitat conditions in the action area would greatly improve as discussed below.

6.2.5. *Post-Dam Removal*

Removing the Veazie Dam will benefit Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon in the Penobscot River. The sections below discuss the effects to Atlantic salmon and sturgeon likely to result following the completion of dam removal activities.

6.2.5.1.*Atlantic salmon*

Following dam removal, Atlantic salmon adults and smolts would no longer experience dam-related fish passage delays, injury or death resulting from interactions with the Veazie Dam. Adult Atlantic salmon returning to spawn in the Penobscot River would no longer have to negotiate fishways at the two projects or suffer migration delay or handling stress associated with the fishway trap. Atlantic salmon smolts would no longer experience delays, injury, and death due to an ineffective downstream fishway.

Designated critical habitat in the project areas will also improve for Atlantic salmon following dam removal. Removal of the Veazie Dam will restore free-flowing riverine habitat in the Penobscot River. Based on substrate mapping and hydraulic modeling (Trust 2008), those restored free-flowing river reaches could restore suitable habitat for spawning and rearing by Atlantic salmon. Removing the dam will also improve water quality, reduce vulnerability to losses from predation, and contribute to restored nutrient exchange and balance in the Penobscot River and Gulf of Maine (Trust 2008). These ecosystem benefits are likely to reduce predation on juvenile Atlantic salmon in the Penobscot River following dam removal. Table 4 summarizes the condition of essential features of Atlantic salmon critical habitat following removal of the Veazie Dam.

6.2.5.2.*Atlantic and shortnose sturgeon*

The removal of the Veazie Dam will allow sturgeon to access 22 rkm of habitat upstream of these projects. As explained above, sturgeon are thought to have historically ranged as far upstream as Milford Falls (rkm 70). The removal of the Veazie Dam will allow Atlantic and shortnose sturgeon to access habitat that has been blocked for over 100 years. Beneficial effects resulting from restoration of this access are likely to include improved spawning success due to additional habitat and improved survival of early life stages and juveniles due to an increase in available low salinity habitat. It is then reasonable to expect that the removal of the Veazie Dam will result in an increase in the abundance and distribution of Atlantic and shortnose sturgeon in the Penobscot River. As there will be more accessible habitat, the dam removal will also result in an increase in the theoretical carrying capacity of the river.

6.3. **Effects of Howland Dam Surrender and Bypass Construction**

The primary effects associated with the Howland Project include construction of the fish bypass, removing the turbines, and lowering the impoundment 1.2 meters. All life stages of Atlantic salmon could be affected by these activities. As Atlantic and shortnose sturgeon do not occur in the project area, and this work will be completed prior to the removal of the Veazie Dam, no effects to sturgeon are expected. The direct and indirect effects of constructing the bypass and lowering the impoundment on listed Atlantic salmon are described below.

6.3.1. *Water Quality*

Sediments and Turbidity

Little in-stream work will be needed to construct the fish bypass at the Howland Project. The new bypass will be constructed around the project powerhouse in predominately upland areas. In-stream work for the fish bypass will be required to construct the opening and exit channel. The bypass would be connected to the river as the final step in the construction process, and timed so that it occurred during summer low flows. Adding flows to the newly constructed bypass could create turbidity in the Piscataquis River downstream of the entrance channel. However, we expect that any increase in either turbidity or sediment to be temporary and short-lived. The effects of sediments and turbidity on Atlantic salmon are detailed above in Section 6.2.1.

Given the limited and temporary nature of any sediments and turbidity, we do not expect any Atlantic salmon mortalities from construction of the fish bypass. Rather, any salmon present in the area are likely to modify their behavior in order to avoid turbid waters. Atlantic salmon experiencing elevated TSS levels are likely to relocate to downstream areas until conditions improve to resume their upstream migration.

Contaminants

Use of heavy equipment near a water body introduces the risk that toxic contaminants (e.g., fuel, oil, etc.) could enter the Piscataquis River. Given the limited amount of actual instream work associated with constructing the fish bypass, the likelihood of any chemical contamination in the Piscataquis River is remote. Nevertheless, to reduce the potential for introducing contaminants into the river during construction activities, the Trust will require the contractor to follow several BMPSs including: a) no equipment, materials, or machinery shall be stored, cleaned, fueled or repaired within any wetland or watercourse; b) dumping of oil or other deleterious materials on the ground will be forbidden; c) the contractor shall provide a means of catching, retaining, and properly disposing of drained oil, removed oil filters, or other deleterious material; and d) all oil spills shall be reported immediately to the appropriate regulatory body. These BMPs will reduce the likelihood of any contaminant releases into the river during construction activities. Based on implementation of this plan, NMFS does not anticipate any significant effects to Atlantic salmon as a result of contaminants from heavy equipment in the action area.

Sediment cores taken from the proposed location of the fish bypass indicate that some soils are contaminated. Elevated levels of arsenic, lead, and PAHs were detected in sediment cores. In accordance with applicable state law, excavate materials with elevated levels of contaminants will be dispose at a state-owned landfill. Given that clean fill will be used to construct the fish bypass, NMFS does not anticipate any leaching of contaminants into the Piscataquis River during or following construction of the bypass.

6.3.2. *Fish Passage*

Removal of the turbines along with construction of the fish bypass and improvements to downstream passage will benefit Atlantic salmon passage in the Piscataquis River. The design of the fish bypass was developed in consultation with state and federal fisheries agencies including NMFS through a series of design meetings. Preliminary design plans were reviewed and approved by each agency. The fish bypass is expected to improve safe, timely, and effective passage of diadromous fish including Atlantic salmon. We anticipate that the bypass will be highly effective at passing upstream migrating adult salmon and will also be utilized by smolts. The new overflow gate is also expected to be highly effective at passing kelts and smolts in a safe, timely, and effective manner. Following construction of the bypass and removal of the turbine units, Atlantic salmon adults and smolts would no longer experience turbine entrainment or impingement. As the bypass is expected to pass alosids and other anadromous fish species, the forage and prey base of the Piscataquis River is expected to increase. This ecosystem benefit is likely to reduce predation on juvenile Atlantic salmon in the Penobscot River following dam removal.

Although the construction of the bypass at Howland is anticipated to improve passage conditions at the Project, the dam will continue to effect upstream and downstream migration of Atlantic salmon as long as it is in place. It is not known how well the nature-like bypass will perform, but as it has been designed to provide safe, timely, and effective passage, it is expected that it will pass at least 95% of motivated pre-spawn salmon. It is expected that salmon will still face some level of migratory delay, and that the fish that are not able to pass the project will likely stray back to the mainstem of the Penobscot. These fish could be adversely affected as they will be precluded from accessing high quality spawning and rearing habitat in the Piscataquis River watershed. Therefore, 5% of upstream migrating Atlantic salmon could be subject to delay, or forced straying, that could affect their ability to spawn in suitable habitat.

As the spillway will not be removed, it is anticipated that some proportion of smolts will be killed annually due to downstream passage at the Howland Project. Alden Lab (2012) estimated smolt and kelt mortality due to passage over the spillway at three percent and passage through a downstream bypass at one percent. After the construction of the bypass and the removal of the turbines at Howland, it is estimated that at average May flows 60% of flow will pass over the spillway, 20% will go through the newly constructed nature like fish bypass, and 20% will flow through the dam gates. It is assumed that survival through the gates will approximate survival through the bypass. This flow distribution would lead to a maximum annual smolt mortality rate of 7.2% (((60% x 3%) + (20% x 1%) + (20% x 1%)) + 5% indirect mortality= 7.2%), assuming smolts pass the project in proportion to the flow. This is a 3.2% improvement over the current minimum survival rate calculated by Alden (2012) of 89.6%. The estimated survival rate includes the 5% indirect mortality estimate, which would likely be reduced by the removal of the turbines. However, Alden cites the primary cause of indirect mortality as high levels of predation downstream of the project, which is not likely to be reduced by the removal of the turbines. That said, the fact that turbine entrainment will no longer occur at the Project would suggest that the 92.8% is a conservative estimate of long-term survival after the proposed project has been implemented. Therefore, it is expected that no more than 7.2% of outmigrating smolts or kelts will be killed due to passage at the Howland Project after the project has been completed.

Following installation of the fish bypass, the Trust proposes to monitor its effectiveness for a 15-year period. If at the end of this period it is determined that the fish bypass is not providing safe, timely or efficient passage for migratory fish species, then the Trust will consider removing the Howland Dam.

6.3.3. *Atlantic Salmon Critical Habitat*

Construction of the Howland fish bypass may temporarily reduce the status of several habitat indicators relative to Atlantic salmon critical habitat. We expect that construction of the bypass will cause temporary adverse effects to some primary constituent elements of critical habitat, including water quality. However, these adverse effects would be short-term and limited in nature and cease when construction of the bypass is completed. Upon completion of the bypass and lowering the impoundment (1.2 meters), overall habitat conditions in the action area would be improved. Based on substrate mapping and hydraulic modeling (Trust 2008), the lowered impoundment could restore suitable habitat for spawning and rearing by Atlantic salmon. Lowering the impoundment could also improve water quality and reduce vulnerability to losses of salmon to predation. Table 8 summarizes the condition of essential features of Atlantic salmon critical habitat following construction of the fish bypass and lowering the impoundment of the Howland Dam. The construction of the bypass and the removal of the turbines is also expected to lead to improvement in the functioning of the migratory PCE in the action area.

6.4. **Effects of Other Activities**

The final phase of the project will involve stabilization and close out. Any remaining structures and remnants of structures along the banks and within the newly exposed banks will be removed; banks will be stabilized and planted as necessary; accessways will be removed and restored; and sediment and erosion controls will be removed.

At the Howland Project, the existing log sluice will be retrofitted to provide downstream fish passage and attraction flow after completion of bypass channel construction. The bypass itself is also expected to pass a significant number of downstream migrating migratory fish species. The final phase of construction will complete grading and site restoration, upland landscape plantings (including top soiling and seeding of disturbed areas), and removal of erosion controls.

In addition, dam removal and water level draw downs may necessitate protection and/or modification of existing infrastructure near the Veazie, Great Works, and Howland Projects. The Trust anticipates the following additional work: 1) extension of an existing boat launch in Eddington, Maine; 2) placement of stone riprap at existing storm drains, culverts, and other outlets for erosion control; 3) placement of erosion control blanket over sandy-silt deposits for temporary stabilization; 5) placement of stone riprap at the base of existing walls as a splash pad; and 6) the Old Town sewer outfall extension. Aside from the sewer outfall extension, the exact scope and extent of these infrastructure modifications cannot be determined until dam removal has been completed and each site is surveyed. The ACOE and NMFS informally consulted on the Old Town sewer outfall extension and approved by extension on April 12, 2012. The ACOE anticipates that the remaining ancillary work will be localized and small in nature.

Approximately 18.4 cubic meters of fill covering 418.1 square meters of river bottom will likely be needed for erosion control at the Veazie site. Approximately 133.8 cubic meters of fill will be needed to extend the Eddington boat launch and for reinforcement of storm drains, culverts, etc. The Corps has conditioned the permit such that these activities occur between July 1 and April 9. Downstream migration of Atlantic smolts occurs during the spring; therefore, smolts will not be present in the action area during implementation of these activities. The use of proper BMPs will help ensure that any effects of sedimentation are insignificant to any Atlantic sturgeon, shortnose sturgeon or adult Atlantic salmon in the action area. Therefore, effects of these activities will be insignificant and discountable.

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. Future Federal actions are not considered in the definition of "cumulative effects." It is important to note that the definition of "cumulative effects" in the section 7 regulations is not the same as the NEPA definition of cumulative effects.

Actions carried out or regulated by the State of Maine within the action area that may affect NMFS listed species and critical habitat include the authorization of state fisheries and the regulation of dredged material discharges through CWA 401-Certification and point and non-point source pollution through the National Pollutant Discharge point and non-point source pollution through the National Pollutant Discharge Elimination System (NPDES). We are not aware of any local or private actions that are reasonably certain to occur in the action area that may affect listed species.

State Water Fisheries - Future recreational and commercial fishing activities in state waters may take shortnose and Atlantic sturgeon. Information on interactions with shortnose and Atlantic sturgeon and the GOM DPS of Atlantic salmon for state fisheries operating in the action area is summarized in the Environmental Baseline section above, and it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Status of the Species/Environmental Baseline section. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the status of the species and environmental baseline sections of this Opinion. It is possible that occasional recreational fishing for anadromous fish species may result in incidental takes of these species. There have been no documented takes of shortnose sturgeon from fisheries in the action area although one Atlantic sturgeon was captured by an angler in 2005. The operation of these hook and line fisheries and other fisheries could result in future sturgeon or Atlantic salmon mortality and/or injury.

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 in the Penobscot River was authorized by the MASC for 2007. The fishery was closed prior to the 2009 season. Despite strict state and federal regulations, both juvenile and Atlantic salmon remain vulnerable to injury and mortality due to incidental capture by recreational anglers and as bycatch 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.

State PDES Permits – The State of Maine has been delegated authority to issue NPDES permits by the EPA. These permits authorize the discharge of pollutants in the action area. Permitees include municipalities for sewage treatment plants and other industrial users. The states will continue to authorize the discharge of pollutants through the SPDES permits. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the status of the species and Environmental Baseline sections of this Opinion.

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

Contaminants associated with the action area are directly linked to industrial development along the waterfront. PCBs, heavy metals, and waste associated with point source discharges and refineries are likely to be present in the future due to continued operation of industrial facilities. In addition many contaminants such as PCBs remain present in the environment for prolonged periods of time and thus would not disappear even if contaminant input were to decrease. It is likely that shortnose sturgeon, Atlantic sturgeon and Atlantic salmon will continue to be affected by contaminants in the action area in the future.

Industrialized waterfront development will continue to impact the water quality in and around the action area. Sewage treatment facilities, manufacturing plants, and other facilities present in the action area are likely to continue to operate. Excessive water turbidity, water temperature variations and increased shipping traffic are likely with continued future operation of these facilities. As a result, shortnose sturgeon foraging and/or distribution in the action area may be adversely affected.

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival.

8. INTEGRATION AND SYNTHESIS OF EFFECTS

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon. In addition, the analysis will determine whether the proposed action will adversely modify designated critical habitat for Atlantic salmon.

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

Recovery is defined as, “Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act.” Below, for the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon, the listed species that may be affected by the proposed action, we summarize the status of the species and considers whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of that species, as those terms are defined for purposes of the Federal Endangered Species Act.

We have estimated that the proposed action will result in harm or harassment to Atlantic salmon, shortnose sturgeon and Atlantic sturgeon in the action area. While lethal injuries and/or mortalities are being reduced by adhering to construction BMPs and modifying operation during the smolt outmigration, it is anticipated that some smolts will be mortally injured or killed as a result of the interim operations of the Projects considered in this Opinion. In addition, the Howland Project, which is not proposed to be removed will continue to cause delay, straying, injury, and mortality to migrating Atlantic salmon.

8.1. Atlantic Salmon

Atlantic salmon in the GOM DPS currently exhibit critically low spawner abundance, poor marine survival, and are still confronted with a variety of threats. The abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS.

We find that removal of the Veazie Project and surrender of the Howland Project license will greatly improve upstream and downstream passage for Atlantic salmon and improve several critical habitat features in the lower Penobscot River watershed. However, we also find that during the interim operating period, the proposed project would continue to adversely affect Atlantic salmon and its critical habitat. While FERC and the Trust propose several measures to reduce adverse impacts of project operation during the interim operating period, the proposed project would still adversely affect habitat characteristics and inhibit upstream and downstream passage. Operations would also temporarily adversely affect some essential features of Atlantic salmon critical habitat, including water quality, substrate, cover and shelter, safe passage, and rearing and spawning.

The dam removal process and construction of the Howland fish bypass would also cause short-term impacts to Atlantic salmon in the form of increased suspended sediments concentrations in the action area and delays in fish passage. We determined that these effects, due to their short-term nature, are not likely to significantly reduce the functioning of already impaired habitat or retard the progress of impaired habitat towards properly functioning condition within the timeframe specified in this Opinion (three years). The proposed action includes numerous measures that should reduce the adverse impacts of interim operations and in-stream work on listed species and critical habitat. However, the remaining dam structure at Howland will affect upstream and downstream migrating Atlantic salmon over the long term by causing delay and straying of upstream migrating pre-spawn adults, as well as delay, injury, and mortality of outmigrating smolts and kelts.

We expect that the condition of many habitat features in the action area will greatly improve for Atlantic salmon after removal of the Veazie Dam and surrender of the Howland Project license. Removal of the Veazie Dam and construction of the fish bypass at Howland will improve passage conditions, eliminate turbine entrainment and impingement, improve water quality, improve rearing and spawning habitat, and improve prey resources in the river.

Jeopardy is defined by USFWS and NMFS (1998) 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.” 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. To facilitate this analysis, NMFS and USFWS have independently constructed models to determine how hydroelectric facilities affect the GOM DPS of Atlantic salmon (NMFS 2012, USFWS 2012). The models utilize life history characteristics and estimated passage and survival rates at dams in the Penobscot River watershed to determine how the proposed project will affect the numbers, reproduction and distribution under survival and recovery conditions.

The Dam Impact Assessment (DIA) model created by NMFS (2012) evaluated the relative effect that changes in various inputs could have on the abundance of returning 2SW female Atlantic salmon to the Penobscot River. As part of the analysis, NMFS analyzed the effect of removing the Great Works and Veazie dams, as well as the construction of a nature-like bypass around the Howland Project. The DIA model used the following inputs in its analysis:

- Initial number of 2SW females spawners
- Eggs per female
- Freshwater Survival (Egg to smolt)
- In-River Survival (Outmigration)

- Smolt production caps
- Hatchery Stocking Levels and Location
- Downstream passage estimates (Alden)
- Downstream passage estimate correlation
- Path choice (Stillwater or mainstem)
- Hatchery discount
- Marine Survival
- Broodstock collection
- Natural Straying Rate
- Dam mortality
- Dam-induced Straying Rate
- Pre-spawn adult upstream passage efficiencies

As the DIA model incorporated the removal of the Great Works Dam, which has already been completed, as part of the proposed project, the results of the model are an overestimate of what would be expected to result from the remaining components of the project (removal of the Veazie Project and the construction of the Howland fish bypass). However, the DIA model makes it clear that these components, in addition to the Great Works Dam removal, will substantially improve passage conditions and survival of Atlantic salmon in the Penobscot River.

According to the DIA model (NMFS 2012), the removal of the Great Works and Veazie Dams, as well as the construction of the bypass around Howland, will increase both the proportion of outmigrating smolts surviving to Verona Island at the mouth of Penobscot Bay, and the proportion of returning 2SW females. The model predicts that the dam removals will lead to a 68% relative reduction in the proportion of outmigrating salmon smolts that are killed prior to reaching the estuary when compared to the baseline conditions. The DIA model also predicts a 79% relative increase in the number of returning 2SW female Atlantic salmon when compared to existing conditions (Figure 7).

As illustrated in Figure 7, the model indicates a significant decline in 2SW female returns between the first and second generations prior to leveling out for the next nine generations. Although in generation one the model allows for 587 females to spawn in the system, the majority of their progeny do not survive to the adult stage due to freshwater and marine mortality factors. As such, they have very little effect on the subsequent adult returns and generations two through ten are primarily being driven by the return rate for the stocked smolts. In short, the 'wild' spawners in generation one are providing very little benefit to the subsequent adult returns under the baseline survival conditions and any benefit provided quickly dissipates as the generations progress.

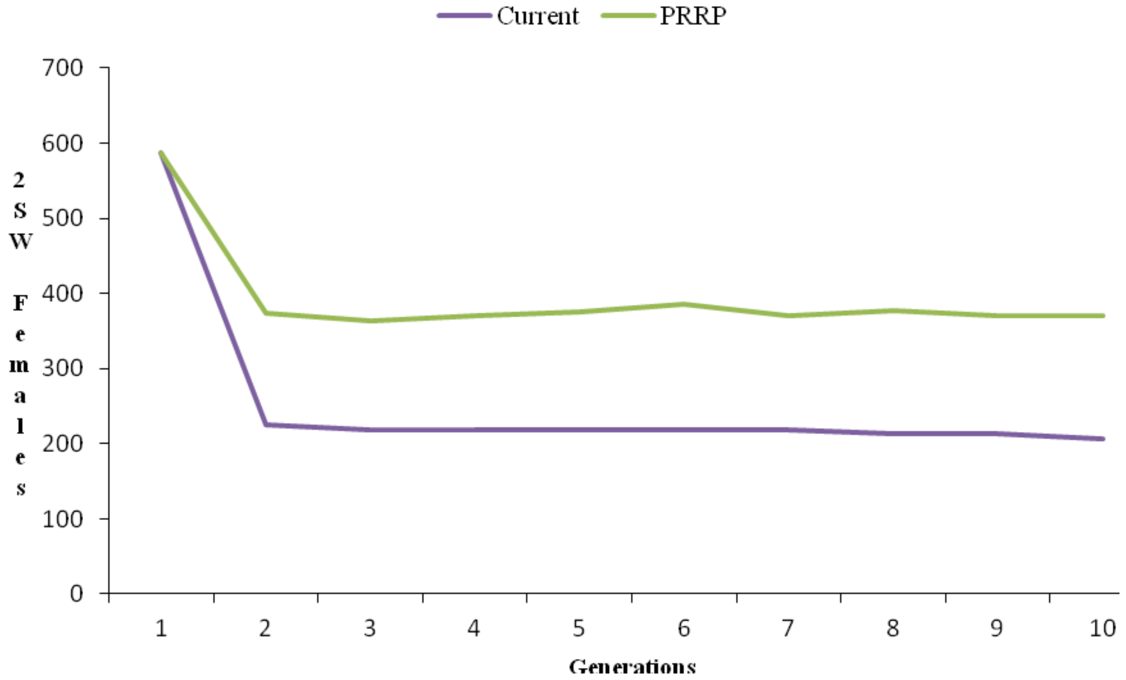

Figure 7. Comparison of the simulated number of returning 2SW female Atlantic salmon over ten generations according to the DIA model under existing conditions and conditions expected after the removal of the Veazie and Great Works Dams, as well as the construction of a bypass around the Howland Dam (PRRP).

USFWS (2012) conducted a separate life history model to assess the adequacy of the performance standards proposed by Black Bear Hydro Partners for its hydroelectric projects on the Penobscot; and, in so doing, also looked at the effects of the dam removals on total smolt survival and adult returns. The USFWS (2012) model shows similar results to the DIA model, indicating that the dam removals would increase total smolt survival from 64% to 74%, as well as increase cumulative upstream passage success through the Penobscot River dams from 72% to 95%. The USFWS model calculated a population growth rate (λ or lambda) for the various scenarios, and determined that the dam removals associated with the PRRP will increase λ in the Penobscot River from 0.65 to 0.82, assuming low marine survival. A population that has a λ below 1 is a declining population that is below the replacement rate; however, the model indicates that the removal of the dams under poor marine survival conditions still shows a significant increase in the population's rate of growth. USFWS (2012) also calculated λ under high marine survival conditions and determined that the dam removals associated with the PRRP would cause it to increase from 0.85 to 1.07. Lambda values above 1.0 indicate that a population has a positive growth rate.

The DIA model (NMFS 2012) also predicted the effect that the dam removals will have on the distribution of Atlantic salmon in the Penobscot River. The metric used for distribution was the proportion of Atlantic salmon runs where at least one 2SW female successfully migrated past the West Enfield Project in the mainstem of the Penobscot, or the Howland Project in the Piscataquis River. These landmarks were chosen as 92% of high quality spawning and rearing habitat in the

Penobscot River watershed occurs upriver of these locations (NMFS 2009). Access to this habitat is critical to the survival and recovery of the species in the Penobscot Bay SHRU. The model indicates that after ten generations under existing conditions only 64% of runs will have individuals accessing the habitat in the Upper Penobscot and the Piscataquis Rivers. After the dam removals have been completed, however, the DIA model predicts that the proportion of successful runs could increase to 90%, a 41% relative increase over existing conditions (Table 9).

Table 9. The proportion of runs anticipated where 2SW female Atlantic salmon are able to access high quality habitat in the upper Penobscot River (above West Enfield) and in the Piscataquis River (above Howland) over ten generations.

	Upper Penobscot		**Piscataquis**	
Generation	**Current**	**PRRP**	**Current**	**PRRP**
1	100%	100%	100%	100%
2	68%	91%	68%	91%
3	64%	90%	65%	90%
4	64%	90%	65%	91%
5	63%	90%	64%	90%
6	64%	90%	65%	90%
7	64%	91%	64%	91%
8	63%	90%	64%	91%
9	64%	91%	65%	91%
10	64%	90%	64%	90%

The results from both the NMFS (2012) and USFWS (2012) models indicate that the Trust's proposed project in the Penobscot River, will lead to a significant increase in the abundance, reproduction and distribution of Atlantic salmon in the Penobscot River watershed, as well as the GOM DPS as a whole. Although the action under consideration in this Opinion does not include the removal of the Great Works Dam, it is clear that the removal of the Veazie Dam and the construction of a fish bypass around the Howland Dam will contribute to the results described above. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic salmon will survive.

Recovery Analysis

In certain instances an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that Atlantic salmon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate.

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

At existing freshwater and marine survival rates (the medians have been estimated by NMFS as 1.1% and 0.4%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. As indicated in the survival analysis above, at current survival rates wild spawners are having a very small effect on the number of returning salmon. If hatchery supplementation were to cease, the population would decline rapidly, and recovery would not be possible. Therefore, a significant increase in either freshwater or marine survival (or a lesser increase in both) will be necessary to achieve recovery. The Atlantic Salmon Recovery Team (ASRT) created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (ASRT 2010). In Figure 8, the red dot represents current marine and freshwater survival rates; the blue 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 blue line, the population is growing, and, thus, trending towards recovery (lambda greater than one). The red lines indicate the rates of freshwater survival that have been historically observed (Legault 2004). This model indicates that there are many potential routes to recovery; for example, recovery could be achieved by significantly increasing the existing marine survival rate while holding freshwater survival at existing levels, or, conversely, by significantly increasing freshwater survival while holding marine survival at today's levels. Conceptually, however, the figure makes clear that an increase in both freshwater and marine survival will lead to the shortest and, therefore, most likely to occur, path to achieving a self-sustaining population that is trending towards recovery.

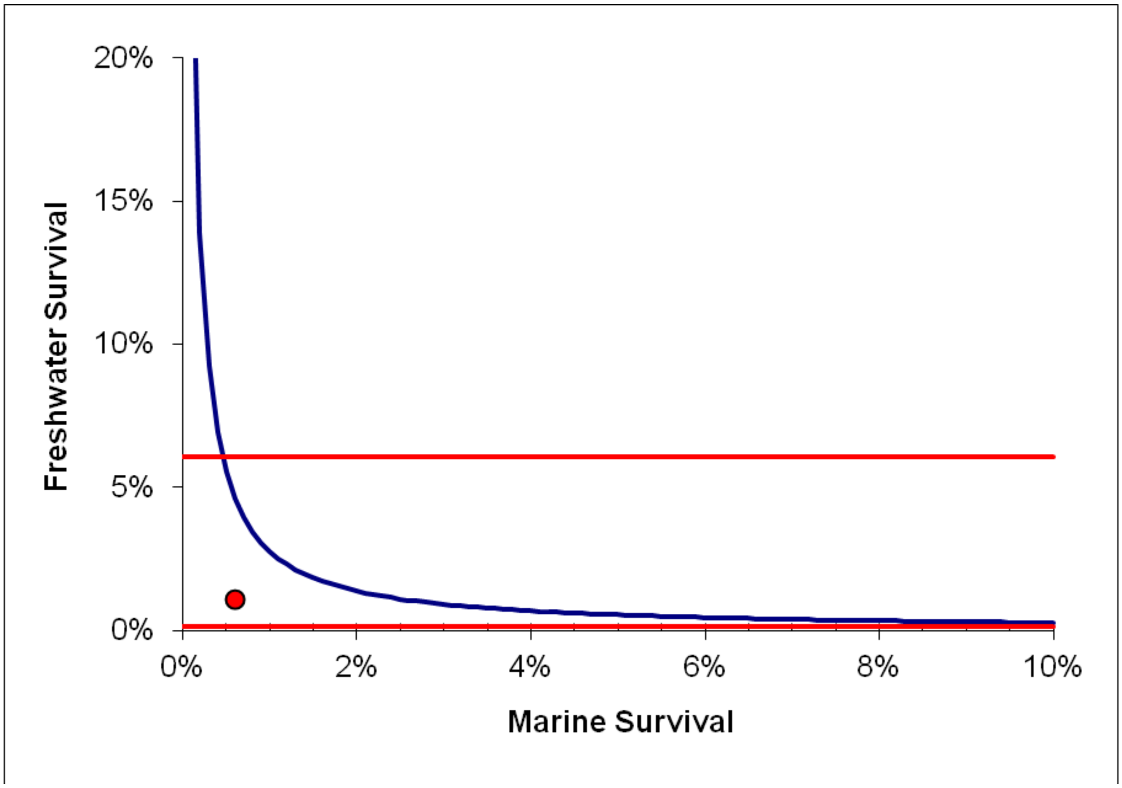

Figure 8. A conceptual model constructed by ASRT (2010) that demonstrates how changes in marine and freshwater survival will be necessary to recover the GOM DPS of Atlantic salmon. The red dot represents current conditions, the blue line represents recovery, and the red lines are the historic maximum and minimum freshwater survival.

In order to model the effect that the proposed action would have on recovery, marine and freshwater survival rates are increased to a point that will allow for the recovery of the species. To do this, assumptions are made about what constitutes a realistic increase in these parameters. In the mid-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 for which are unknown at this time (Windsor *et al.* 2012). Based on the smolt to adult return rate for wild fish in the Narraguagus River, USFWS (2012) estimated that the pre-regime shift marine survival rate ranged between 0.9% and 5.2%, with an average of 3.0%. A four-fold increase in the current median marine survival rate (from 0.4% to 1.7%) will allow for a rate that is within the range estimated to have existed prior to the regime shift.

Freshwater survival rates have historically ranged between 0.1% and 6.0%, with an average of 1.5% (Legault 2004). A two fold increase in the existing median freshwater survival rate (from 1.1% to 2.2%) creates a condition that is above the historical mean, but is within the range that has been observed and, when coupled with improved marine survival, will allow for a modest positive growth rate in the Atlantic salmon population.

While interim operations of the Veazie and Howland Projects will result in some loss of Atlantic salmon smolts and adults, the ultimate removal of the Veazie Dam and construction of a bypass around Howland will improve the long-term recovery potential of the species. Therefore, we have determined that the proposed action will not appreciably reduce the likelihood that Atlantic salmon will recover in the wild.

8.2. Critical Habitat for the GOM DPS of Atlantic salmon

Critical habitat for Atlantic salmon has been designated in the Penobscot River including the sections of river in the vicinity of the Veazie and Howland Projects. 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 habitat in the proposed project area primary functions as a migration corridor for migrating pre-spawn adults, as well as for outmigrating smolts and kelts.

Summary of Construction Effects

The removal of the Veazie Dam on the mainstem will temporarily reduce the functioning of critical habitat in the vicinity of the Project. The area will be made unsuitable for Atlantic salmon migration due to elevated turbidity and noise levels associated with construction activities. The effects will be of short duration and, as the majority of work will occur within dewatered cofferdams, it is expected that exposure to the effects will be minimal. It is expected that temporary construction effects will cause fish to avoid the project area for short periods of time. The lowering of the impoundment will make the Veazie upstream fishway inoperable, which will significantly affect the functioning of the migration PCE within the Penobscot for a three to four week period, prior to the breaching of the dam.

The demolition of the Veazie Dam will require the placement of a significant amount of temporary fill below the ordinary high water (OHW) line in the Penobscot River. The entirety of the temporary fill will be placed and removed outside of the spring outmigration period. In addition, the lowering of the impoundment will affect migration habitat by making the fishway inoperable for a period of three to four weeks. Therefore, activities associated with the dam removal will lead to significant, but temporary, effect on the migration PCE.

Summary of Passage Effects

The removal of the Veazie Dam will significantly improve the functioning of the migratory PCE by increasing upstream and downstream survival to what would be expected in an unimpounded reach. Likewise, levels of migratory delay, injury, and forced straying associated with the presence of the dam will be significantly reduced or eliminated.

The decommissioning of the Howland Dam in the Piscataquis River, as well as the construction of a fish bypass, is anticipated to improve upstream and downstream survival at the Project. However, we expect that the Howland Dam would continue to harm the PCEs in the action area after the project has been completed. We expect the continued presence of the dam structure will cause adverse effects to some essential features of critical habitat. Specifically, it is expected that downstream passage via the spillway and bypass will continue to negatively affect migration by causing injury and mortality to outmigrating smolts and kelts. However, with the removal of the turbines, it is expected that survival rates will be improved.

Overall, designated critical habitat in the Penobscot River watershed is anticipated to significantly improve for Atlantic salmon with the implementation of the proposed project. Therefore, the proposed project is not likely to adversely modify or destroy Atlantic salmon critical habitat.

8.3. Shortnose Sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The shortnose sturgeon residing in the Penobscot River come from one of these nineteen populations. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard (1996), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for five of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

Shortnose sturgeon will not be able to access the Howland Project during construction as the extent of their historic range is thought to be the falls at the existing location of the Milford Project (L. Flagg, MDMR, pers. comm. 1998), and even after the removal of the Veazie Dam it is not expected that sturgeon will move beyond this location. Therefore, the species will not be exposed to any effects associated with the construction of the new fish bypass. Likewise, it is not anticipated that the operation of the fish bypass will affect shortnose sturgeon in the river.

It is expected that the Veazie Dam removal will restore a significant amount of habitat to shortnose sturgeon in the Penobscot River. The removal will allow shortnose sturgeon access to habitat all the way up to the base of the Milford Dam, 22 river kilometers upstream of Veazie on the mainstem. It is anticipated that the removal of the dam will provide natural passage to all historic spawning and rearing habitat for shortnose sturgeon.

The interim operation of the Veazie Project prior to removal is likely to result in the continued disturbance of shortnose sturgeon by precluding access to upstream habitats and by restricting freshwater habitats needed for the successful development of larvae and young of the year sturgeon. The continued operation of the Veazie Project over the interim period is likely to continue to reduce the amount of successful spawning in the Penobscot River, and reduce the viability of young sturgeon by restricting the amount of freshwater habitat available for development. Overall, the continued operation of the Veazie Project will continue to depress reproductive success for shortnose sturgeon in the Penobscot River. However, as the proposed action includes the removal of the Veazie Dam these effects will be temporary. The interim operation of the Veazie project is not likely to directly result in the mortality of any adult shortnose sturgeon although it may indirectly contribute to the mortality of early life stages, including juveniles, due to its limiting access to freshwater rearing habitat.

The removal of the Veazie Dam will restore access to approximately 22 rkm of habitat for both sturgeon species found in the action area (Trinko Lake *et al.* 2012). This is likely to improve spawning and rearing success and may provide additional foraging and overwintering opportunities. The restoration of access to their historic range in the river is likely to result in an increase in carrying capacity and an increase in abundance and distribution of shortnose sturgeon in the Penobscot River.

While the ultimate effect of dam removal will be beneficial, the act of removing the Veazie Dam is likely to result in the disturbance of all present life stages of shortnose sturgeon by temporarily displacing them from habitats affected by dam removal activities. However, these effects are likely to be temporary. Removal of the Veazie Dam will occur in phases with river flow manipulated by the existing dam and the temporary access roads so that the majority of the work occurs in the dry. Work to remove the Veazie Dam is expected to be limited to one construction season (July 1 – early December) but may take two seasons. Based on the best available information, sturgeon could be present near the Veazie Dam between April 1st and early October; as such, any sturgeon present near the dam during that time period would be precluded from accessing certain areas of the river blocked by the temporary access roads. However, as the area where access will be precluded will be small and the area is not known to be used for foraging or overwintering, and sturgeon are expected to have sufficient zone of passage to complete all essential behaviors, the effects of this disturbance are likely to be insignificant. Similarly, in-river work required for the removal of the remnant dam upstream of Veazie is also expected to result in the temporary disturbance of sturgeon due to the placement of temporary access roads in the river. However, as river flow will be diverted around these roads and removal activities will occur in dewatered areas, all effects are likely to be insignificant and discountable.

The action is also not likely to directly reduce the numbers of shortnose sturgeon in the action area as there will be no mortality of any individuals and no reason sturgeon would abandon the action area during the spawning season. The distribution of shortnose sturgeon within the action area will be improved by the removal of the Veazie Dam, as they will have access to the entirety of their historic range in the Penobscot River.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for shortnose sturgeon in the wild (i.e., the likelihood that the species will continue to exist in the future while retaining the potential for recovery). The action will not affect sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate.

Thus, we have considered whether the proposed action will appreciably reduce the likelihood that shortnose sturgeon can rebuild to a point where shortnose sturgeon are no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for shortnose sturgeon was published in 1998 pursuant to Section 4(f) of the ESA. The Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely. However, the plan states that the minimum population size for each population has not yet been determined. The Recovery Outline contains three major tasks, (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect shortnose sturgeon in a way that would affect the species likelihood of recovery.

This action will not change the status or trend of any Gulf of Maine population of shortnose sturgeon or the species as a whole. This is because there will be no reduction in numbers and the impact on reproduction and future year classes will also be small enough not to affect the stable trend of the population. The proposed action will have only insignificant effects on habitat and distribution in the short term. In the long term, it will improve conditions in the river in a way that makes additional growth of the population more likely, that is, it is expected to increase the river's carrying capacity. Because it will restore access to historical habitat and increase the range of sturgeon in the river, the action is likely to improve the likelihood that the Penobscot River population can recover. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual shortnose sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will impact sturgeon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to sturgeon in the action area are anticipated over the life of the proposed action (three years). 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 proposed action is likely to benefit the recovery of the species.

8.4. Atlantic Sturgeon

We have estimated that the proposed project may affect individuals from the NYB and GOM DPSs of Atlantic sturgeon. As explained in the "Effects of the Action" section, the Veazie Dam currently blocks passage to potential upstream habitat. Because this effect is not selective for which populations may be affected, we anticipate that the effects from the proposed action could impact both the NYB and GOM DPSs of Atlantic sturgeon. As described previously, we expect Atlantic sturgeon to occur at the following frequencies in the action area: St. John River (Canada) 36%; Gulf of Maine DPS 63% and New York Bight DPS 1%.

Atlantic sturgeon will not be able to access the Howland Project during construction as the extent of their historic range is thought to be the falls at the existing location of the Milford Project (L. Flagg, MDMR, pers. comm. 1998). This is not anticipated to change after the removal of the Veazie Dam. Therefore, the species will not be exposed to any effects associated with the construction of the new fish bypass. Likewise, it is not anticipated that the operation of the fish bypass will affect Atlantic sturgeon in the river.

It is expected that the Veazie Dam removal will restore a significant amount of habitat to Atlantic sturgeon in the Penobscot River. The removal will allow Atlantic sturgeon access to habitat all the way up to the base of the Milford Dam, 22 river kilometers upstream of Veazie on the mainstem (Trinko Lake *et al.* 2012). It is anticipated that the removal of the dam will provide natural passage to all historic spawning and rearing habitat for Atlantic sturgeon.

The interim operation of the Veazie Project prior to removal is likely to result in the continued disturbance of Atlantic sturgeon by precluding access to upstream habitats and by restricting freshwater habitats needed for the successful development of larvae and young of the year sturgeon. The continued operation of the Veazie Project over the interim period is likely to continue to reduce the amount of successful spawning in the Penobscot River, and reduce the viability of young sturgeon by restricting the amount of freshwater habitat available for development. Overall, the continued operation of the Veazie Project will continue to depress reproductive success for Atlantic sturgeon in the Penobscot River. However, these effects will only be temporary as the interim period prior to the removal of the Dam will not exceed three years. The interim operation of the Veazie project is not likely to directly result in the mortality of any adult Atlantic sturgeon although it may indirectly contribute to the mortality of early life stages, including juveniles, due to its limiting access to freshwater rearing habitat.

The removal of the Veazie Dam will restore access to approximately 22 river kilometers of habitat for Atlantic sturgeon found in the action area. This is likely to improve spawning and rearing success for the GOM DPS and may provide additional foraging opportunities for the GOM and NYB DPSs. The restoration of access to their historic range in the river is likely to result in an increase in carrying capacity and an increase in abundance and distribution of Atlantic sturgeon in the Penobscot River.

While the ultimate effect of dam removal will be beneficial, the act of removing the Veazie Dam is likely to result in the disturbance of all present life stages of Atlantic sturgeon by temporarily displacing them from habitats affected by dam removal activities. However, these effects will be temporary. Removal of the Veazie Dam will occur in phases with river flow manipulated by the existing dam and the temporary access roads so that the majority of the work occurs in the dry. Work to remove the Veazie Dam is expected to be limited to one construction season (July 1 – early December). However, it is possible that the remnant dam will need to be removed the following year. Based on the best available information, Atlantic sturgeon could be present downstream of the Veazie Dam between July and October, although it is unlikely they will be in the immediate vicinity of the Project. However, any sturgeon that approach the dam during that time period would be precluded from accessing the work area or areas dewatered due to the diversion of river flow. However, as the area where access will be precluded will be small and the area is not known to be used for foraging or overwintering, and sturgeon are expected to have sufficient zone of passage to complete all essential behaviors, the effects of this disturbance are likely to be insignificant. Similarly, in-river work required for the removal of the remnant dam upstream of Veazie is also expected to result in the temporary disturbance of sturgeon due to the placement of temporary access roads in the river. However, as river flow will be diverted around these roads and removal activities will occur in dewatered areas, all effects are likely to be insignificant and discountable.

8.4.1. *Gulf of Maine DPS of Atlantic Sturgeon*

The action is not likely to directly reduce the numbers of GOM DPS Atlantic sturgeon in the action area as there will be no mortality of any individuals and no reason they would abandon the action area during the spawning season. Any effect to reproduction will be small and limited to the three year period before the Veazie Dam is removed. The distribution of Atlantic sturgeon within the action area will be improved by the removal of the Veazie Dam, as they will have access to what is thought to be the entirety of their historic range in the Penobscot River.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for Atlantic sturgeon in the wild (i.e., i.e., the likelihood that the species will continue to exist in the future while retaining the potential for recovery). The action will not affect sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can rebuild to a point where shortnose sturgeon are no longer in danger of extinction through all or a significant part of its range.

No Recovery Plan for the GOM DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the GOM DPS of Atlantic sturgeon in a way that would affect the species likelihood of recovery.

This action will not negatively affect the status or trend of the Penobscot River population of Atlantic sturgeon or the GOM DPS as a whole. This is because there will be no reduction in numbers and the impact on reproduction and future year classes will also be small enough not to affect the stable trend of the population. The proposed action will have only insignificant effects on habitat and distribution in the short term. In the long term, it will improve conditions in the river in a way that makes additional growth of the population more likely, that is, it is expected to increase the river's carrying capacity. Because it will restore access to historical habitat and increase the range of sturgeon in the river, the action is likely to improve the likelihood that the Penobscot River population can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individuals to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will impact Atlantic sturgeon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to sturgeon in the action area are anticipated over the life of the proposed action. 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 proposed action is likely to benefit the recovery of the species.

8.4.2. *New York Bight DPS of Atlantic Sturgeon*

The action is not likely to directly reduce the numbers of NYB DPS Atlantic sturgeon in the action area as there will be no mortality of any individuals and no reason they would abandon the action area during the spawning season. There will be no effects to reproduction of NYB DPS Atlantic sturgeon. The distribution of Atlantic sturgeon within the action area will be improved by the removal of the Veazie Dam, as they will have access to what is thought to be the entirety of their historic range in the Penobscot River.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival for NYB DPS Atlantic sturgeon in the wild (i.e., i.e., the likelihood that the species will continue to exist in the future while retaining the potential for recovery). The action will not affect sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can rebuild to a point where shortnose sturgeon are no longer in danger of extinction through all or a significant part of its range.

No Recovery Plan for the NYB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the NYB DPS of Atlantic sturgeon in a way that would affect the species likelihood of recovery.

This action will not negatively affect the status or trend of the Hudson or Delaware river populations of Atlantic sturgeon or the NYB DPS as a whole. This is because there will be no reduction in numbers and no impact on reproduction. The proposed action will have only insignificant effects on habitat and distribution in the short term. In the long term, it will improve conditions in the river in a way that makes additional growth of the population more likely, that is, it is expected to increase the river's carrying capacity. Because it will restore access to historical habitat and increase the range of sturgeon in the river, the action is likely to improve the likelihood that the NYB DPS population can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individuals to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will impact Atlantic sturgeon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to sturgeon in the action area are anticipated over the life of the proposed action. 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 proposed action is likely to benefit the recovery of the species.

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 shortnose sturgeon, the GOM or NYB DPS of Atlantic sturgeon or the GOM DPS of Atlantic salmon. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of Atlantic salmon critical habitat.

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, nonmigratory, 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 intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The prohibitions against incidental take are currently in effect for the GOM DPS of Atlantic salmon, shortnose sturgeon, and all DPSs of Atlantic sturgeon except the threatened GOM DPS. A final section 4(d) rule for the GOM DPS of Atlantic sturgeon, which we anticipate to be published in the *Federal Register* soon, will apply the appropriate take prohibitions.
The proposed 4(d) rule for the GOM DPS was published on June 10, 2011 (76 FR 34023) and includes prohibitions on take with very limited exceptions. The appropriate prohibitions on take of GOM DPS Atlantic sturgeon will take effect on the date the final 4(d) rule is effective and at that time, the take provided in this ITS will apply to the GOM DPS.

An incidental take statement specifies the amount or extent of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary and appropriate to minimize and/or monitor incidental take and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures. The measures described in this section are nondiscretionary. If the appropriate action agencies fail to include these conditions or the Trust fails to assume and carry out the terms and conditions of this incidental take statement, the protective coverage of section 7(a)(2) may lapse. To monitor the effect of incidental take, the RC must require the Trust to report the progress of the action and its effect on each listed species to NMFS, as specified in this incidental take statement (50 CFR §402.14(i)(3)).

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.

In Section 6, we described the mechanisms by which ESA-listed anadromous fish and designated critical habitat would likely be affected by the Trust’s restoration actions at the Veazie and Howland Projects in the Penobscot River. The following sections describe the amount or extent of take that we expect would result based on the anticipated effects of the proposed action.

If the proposed action results in take of a greater amount or extent than that described above, the RC would need to reinitiate consultation. The exempted take includes only take incidental to the proposed action.

10.1.1. Hydroelectric Operations

We anticipate that the continued operation of the Veazie and Howland Projects for no more than three years (i.e., through December 31, 2015), will harm Atlantic salmon adults and smolts in the Penobscot and Piscataquis Rivers. However, the Trust's proposal to remove the Veazie Dam and construct a nature-like bypass around the Howland Dam will significantly reduce this effect.

Upstream Passage

As described above, section 9(a)(1) of the ESA prohibits any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of endangered species without a specific permit or exemption. The Merriam-Webster Dictionary defines "collect" as "to bring together into one body or place". The dictionary further defines "capture" as "to take captive" and "trap" as "to place in a restricted position". The function of a fishway is to temporarily collect, capture and trap all migrating fish that are motivated to pass a dam, and to provide a mechanism for them to do so. Therefore, it is anticipated that 100% of the Atlantic salmon that use the upstream passage facilities at the Veazie and Howland Projects are collected, captured and trapped and, therefore, could potentially be exposed to the stress, injury and delay associated with being forced into fishways.

Based on ten years of fish passage studies at the Veazie Project, Holbrook *et al.* (2009) indicated that a median of 64% of pre-spawn Atlantic salmon successfully pass the Project. Likewise, Shepard (1995) estimated that pooled passage rates at the Howland Project between 1987 and 1992 were at least 88%. Therefore, it is anticipated that no more than 36% of the Atlantic salmon attempting to pass upstream of the Veazie Project, or 12% attempting to pass the Howland Project, are currently delayed[2], injured, or killed. Although the extent of this effect will be significantly reduced with the implementation of the proposed project, it is expected that this level of take will persist during the interim period (three years for both the Howland and Veazie Projects). Once the fish bypass is completed at the Howland Project and the turbines are removed, we anticipate that the dam will continue to affect upstream and downstream migrating Atlantic salmon. We are unable to estimate how effective the new bypass will be, but as it has been designed to provide safe, timely, and effective passage it is assumed that it will be at least 95% effective. Therefore, no more than 5% of upstream migrating Atlantic salmon are anticipated to be harassed after the interim period due to delay and forced straying that will prevent them from spawning in high quality spawning habitat in the Piscataquis River watershed.

We convened an expert panel in December 2010 to provide the best available information on what happens to the Atlantic salmon that fail to pass a project with an upstream fishway. The

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[2] Delays to fish migrations due to ineffective fishways are considered "harm" to the species pursuant to 64 FR 60727 November 8, 1999.

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). With additional factors, such as high fall back rates and predation, it was estimated that 3% and 2% of the fish that fail to pass the Veazie and Howland Dams, respectively, could be killed. Fish that fail to pass the fishway, but do not die, are harassed, and potentially harmed, by being forced to change their natural reproductive behavior; either by spawning in potentially less suitable habitat downstream, or by dropping back into the ocean without spawning. Therefore, over the three year interim period, it is expected that 64% of salmon that are motivated to pass the Veazie Project will do so successfully but will be collected, captured, and trapped; 35% (97% x 36%) will be harassed as they will fail to pass and, thus, will not be able to access suitable spawning habitat upstream of the Project; and 1% (3% x 36%) will die. Likewise, over the three year interim period, it is expected that 88% of salmon that are motivated to pass the Howland Project will do so successfully but will be collected, captured, and trapped; 11.8% (98% x 12%) will be harassed as they will fail to pass and, thus, will not be able to access suitable spawning habitat upstream of the Project; and 0.2% (2% x 12%) will die. After the project has been implemented, it is expected that no upstream migrating salmon will be killed, but that the 5% that are unable to migrate past the project will be harassed by delay and straying that will prevent them from accessing spawning habitat in the Piscataquis River watershed. As it is not possible to predict with any certainty the number of Atlantic salmon that will be motivated to pass each of the projects on the Penobscot River, the amount of take due to upstream dam passage is provided as a proportion of the upstream migrants that approach each individual project.

Downstream Passage

A significant proportion of Atlantic salmon smolts and kelts are injured or killed during dam passage every year. As it is not possible to predict with any certainty the number of Atlantic salmon smolts and kelts that will be outmigrating past each of the projects on the Penobscot River, the amount of take due to downstream dam passage is provided as a proportion of the smolts and kelts that attempt to pass each individual dam. Based on estimates provided by Alden Lab (2012), the maximum proportion of smolts that are anticipated to be killed due to direct and indirect effects at the Veazie and Howland Projects is 17.3% and 10.4%, respectively. Likewise, the maximum proportion of kelts that are anticipated to be killed due to direct and indirect effects at the Veazie and Howland Projects is 24.7% and 7.7%, respectively. This level of take is not expected to last past the three year interim period. Also, this level of take is likely to occur for only two weeks of the downstream passage season for smolts; during the other two weeks, night-time shutdowns will be implemented to protect smolts and kelts at the Veazie and Howland Projects. It is expected that downstream passage will continue to injure and kill outmigrating smolts and kelts at the Howland Project after the proposed project has been implemented. As the turbines will no longer be operating it is expected that passage will injure or kill no more than 7.2% of outmigrating smolts and kelts annually.

It is not possible to monitor the exact numbers of takes of Atlantic salmon. We will require river temperature monitoring to determine whether turbine shutdowns are initiated at the peak of downstream migrations (i.e., when river temperatures reach 10°C). If water temperature monitoring indicate that turbine shutdowns at the Veazie and Howland Dams occurred significantly earlier or later (i.e., more than seven days) than river temperatures reaching 10°C, the Trust must consult with us to determine whether the timing of shutdowns should be modified. Each year, we will review water temperature data and the dates of turbine shutdowns to determine whether incidental take levels for Atlantic salmon were exceeded.

Shortnose and Atlantic Sturgeon

The proposed action has the potential to affect shortnose and Atlantic sturgeon adults by precluding them from accessing habitat upstream of the Veazie Dam for spawning, and possibly foraging and overwintering. As explained in the "Effects of the Action" section of the accompanying Opinion, the historic range of sturgeon in the Penobscot River is thought to have extended to Milford Falls (rkm 70). The Veazie Dam precludes access to approximately 22 rkm of habitat (Trinko Lake *et al.* 2012). While the dam will be removed as part of the proposed action, interim operations will continue to preclude access for up to three years. The effects of the reduction in available habitat are decreased reproductive success of adults due to a reduction of the available spawning habitat. Interim operations will also affect any larvae and juvenile shortnose sturgeon produced in the three year interim period by limiting the amount low salinity habitat which is crucial for the successful development of early life stages and juveniles, which have reduced tolerances for salinity as compared to adults.

The interim operation of the Veazie Project will be considered harm because the operation of the project precludes access to upstream habitats, which not only disturbs individual sturgeon by interrupting normal behaviors (i.e., migrating upstream of the existing projects) but also impairs their ability to carry out these normal functions by reducing the reproductive fitness of individual sturgeon, by reducing the available habitat for spawning, and by reducing the viability of any offspring. Adult sturgeon spawn every two to three years. Thus, potentially all of the sturgeon spawning in the river would be affected by up to three years of operation at Veazie. Similarly, the proposed action will result in the harm of up to three year classes of any larvae and juveniles as it will impair their ability to develop normally by decreasing the amount of low salinity habitat necessary for successful development of these life stages of sturgeon.

Despite the use of the best available scientific information, we cannot quantify the precise number of either Atlantic or shortnose sturgeon that are likely to be taken. Because both the number of sturgeon attempting to spawn in a given year and the number of larvae and juveniles produced are highly variable and there is no precise estimate of the total population size or the number of individuals spawning in a given year, and because incidental take is indirect and likely to occur from effects to habitat, the amount of take resulting from harm is difficult, if not impossible, to estimate. In addition, because sturgeon are aquatic species who spend the majority of their time on the river bottom and because reduced spawning opportunities and reduced viability of larvae and juveniles are impossible to measure, the likelihood of discovering take attributable to this proposed action is very limited. In such circumstances, we use a surrogate to estimate the extent of take. The surrogate must be rationally connected to the taking and provide an obvious threshold of exempted take which, if exceeded, provides a basis for reinitiating consultation. For this proposed action, the spatial and temporal extent of the habitat from which sturgeon will be precluded from accessing provides a surrogate for estimating the amount of incidental take.

As explained above, the Veazie Project precludes shortnose and Atlantic sturgeon from accessing approximately 22 rkm of upstream habitat, which is thought to represent the full extent of the historic range of sturgeon in this river system. The project also limits the amount of low salinity habitat available for the development of larvae and juveniles to an approximately 16 kilometer stretch from Veazie Dam to Hampden. The extent of take will be limited to those areas above and below the Veazie Dam. As such, we will consider take to have been exceeded if the operation of the Veazie Dam continues for more than three years following the issuance of this Opinion and/or if the proposed action does not result in the restoration of access up to the Milford Dam.

10.1.2. *Dam Removal Activities*

Atlantic salmon

Removal of the Veazie Dam is anticipated to occur between July and December. Based on Atlantic salmon returns between 2007 and 2010, 23% of the run passes the Veazie Project between July and October. Therefore, it is expected that at least 23% of the Atlantic salmon run in the Penobscot could be migrating through the project area during construction activities. As dam demolition will occur in the dry, and as erosion and sedimentation control BMPs will be employed, it is not anticipated that there will be any take of Atlantic salmon due to turbidity and noise effects associated with construction. However, it is possible that a small number of salmon could become stranded within the dewatered work area, or in areas upriver of the dam that are dewatered when the impoundment level is lowered. It is anticipated that up to one Atlantic salmon could become temporarily trapped at the Veazie Project due to dewatering. As qualified fisheries biologists will conduct stranding surveys of isolated pools shortly after dewatering, no salmon are expected to be killed. However, capturing and handling fish causes physiological stress and can cause physical injury although these effects can be kept to a minimum through proper handling procedures. Therefore, the lowering of the Veazie impoundment may potentially harm one adult Atlantic salmon. The construction of the Howland bypass is not anticipated to lead to the stranding of Atlantic salmon as construction will primarily occur in upland areas.

We anticipate that adult Atlantic salmon would be harmed during the dam removal through fish passage delays and exposure to elevated turbidity and sediments. Particularly, the blockage of passage at the Veazie Dam for three to four weeks could affect up to 23% of the salmon in the river. Take is likely to be in the form of harassment resulting in fish passage delays or forced straying to other areas of the river during construction activities.

It is not possible to monitor the exact numbers of takes of Atlantic salmon occurring during removal activities. In this instance, we will assume that take of Atlantic salmon has been exceeded if construction and demolition activities at the Veazie and Howland Dams have not been completed within three years.

Shortnose Sturgeon

Removal of the Veazie Dam is anticipated to occur between July and December. Based on the above information, it is possible that shortnose sturgeon could occur in the habitat downstream of the dam during that timeframe. Demolition of the dam structures will occur after the spawning season for sturgeon so it is not anticipated that construction activities will affect upstream migration behavior. As dam demolition will occur in the dry, and as erosion and sedimentation control BMPs will be employed, it is not anticipated that there will be any take of shortnose sturgeon due to turbidity and noise effects associated with construction. However, it is possible that a small number of sturgeon could become stranded within the dewatered work area, or in the area downriver of the powerhouses, when river flow is diverted. It is anticipated that no more than one shortnose sturgeon could become temporarily trapped at the Veazie Project. As qualified fisheries biologists will conduct stranding surveys of isolated pools shortly after dewatering, no sturgeon are expected to be killed. However, capturing and handling fish causes physiological stress and can cause physical injury although these effects can be kept to a minimum through proper handling procedures. Therefore, the dewatering of the work area and an area downriver of the dam may potentially harm one shortnose sturgeon.

Atlantic Sturgeon

Removal of the Veazie Dam is anticipated to occur between July and December. Based on the above information, it is possible that Atlantic sturgeon could occur in the habitat downstream of the dam during that timeframe. However, field data indicate that Atlantic sturgeon are not likely to occur within the immediate vicinity of the Project during this period. Demolition of the dam structures will occur after the spawning season for sturgeon so it is not anticipated that the project will affect upstream migration behavior. As dam demolition will occur in the dry, and as erosion and sedimentation control BMPs will be employed, it is not anticipated that there will be any take of Atlantic sturgeon due to turbidity and noise effects associated with construction. As Atlantic sturgeon are not expected to occur in the area immediately downriver of the project, it is not anticipated that any will become stranded when the work area is dewatered.

We believe this level of incidental take is reasonable given the seasonal distribution and abundance of Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon in the action area. In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy of any of these species.

10.2. Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon in the action area. Therefore, the action agencies must require that the Trust carry out the following measures:

1. Prior to dam removal, review and use best available science to adaptively manage the dam removal protocol to incorporate any new practices which will minimize impacts to listed Atlantic salmon and shortnose sturgeon.
2. Conduct all operational, dam removal, and any other in-water and near-water construction activities in a manner that minimizes incidental take of ESA-listed or

proposed species and conserves the aquatic resources on which ESA-listed species depend.

3. Minimize incidental take from all dam removal and other in-water and near-water construction activities by applying best management practices to the proposed action that avoid or minimize adverse effects to water quality and aquatic resources.
4. Ensure completion of an annual monitoring and reporting program to confirm the Trust is minimizing incidental take and reporting all project-related observations of dead or injured salmon or sturgeon to NMFS.

6.3. Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, RC, FERC, and the ACOE must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and which outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To carry out RPM#1, RC, FERC, and the ACOE shall ensure that prior to dam removal, the Trust prepare a Final Dam Removal Construction Plan (Construction Plan) in collaboration with NMFS, USFWS, ACOE, and other state agencies.

2. To implement RPM #1, FERC, RC, and the ACOE must require the Trust to do the following:
   a) Prior to initiating dam removal activities, convene state and federal resources agencies to review the dam removal activities and review any new information for potential impacts that were not considered during consultation. If new methods of avoiding and/or minimizing incidental take are identified, the Trust must seek review and approval from NMFS before construction activities commence of any changes in a) dam removal methods and actions; b) take minimization activities; and c) monitoring and contingency activities. Changes to the proposed action or this incidental take statement may be authorized via simple amendment of this Opinion.

3. To implement RPM #2 and #3, FERC, RC, and the ACOE must require the Trust to do the following:
   a) Timing of in-water work: Work below the bankfull elevation will be completed during an in-water work period from July 1 to April 9. The Trust must notify NMFS one week before in-water work begins.
   b) Use Best Management Practices that will minimize concrete products (dust, chips, larger chunks) mobilized by dam removal activities from entering flowing or standing waters. Best practicable efforts shall be made to collect and remove all concrete products prior to rewatering of construction areas.
   c) Employ erosion control and sediment containment devices at the Veazie, Great Works, and Howland Dams construction sites. During dam removal, all erosion control and sediment containment devices shall be inspected weekly, at a minimum, to ensure that they are working adequately. Any erosion control or sediment containment inadequacies will be immediately addressed until the disturbance is minimized.

d) Provide erosion control and sediment containment materials (e.g., silt fence, straw bales, aggregate) in excess of those installed, so they are readily available on site for immediate use during emergency erosion control needs.
e) Ensure that vehicles operated within 46 meters (150 feet) of the construction site waterways will be free of fluid leaks. Daily examination of vehicles for fluid leaks is required during periods operated within or above the waterway.
f) During construction activities, ensure that BMPs are implemented to prevent pollutants of any kind (sewage, waste spoils, petroleum products, etc.) from contacting water bodies or their substrate.
g) In any areas used for staging, access roads, or storage, be prepared to evacuate all materials, equipment, and fuel if flooding of the area is expected to occur within 24 hours.
h) Perform vehicle maintenance, refueling of vehicles, and storage of fuel at least 46 meters (150 feet) from the waterway, provided, however, that cranes and other semi-mobile equipment may be refueled in place.
i) At the end of each work shift, vehicles will not be stored within, or over, the waterway.
j) Prior to operating within the waterway, all equipment will be cleaned of external oil, grease, dirt, or caked mud. Any washing of equipment shall be conducted in a location that shall not contribute untreated wastewater to any flowing stream or drainage area.
k) Use temporary erosion and sediment controls on all exposed slopes during any hiatus in work exceeding seven days.
l) Place material removed during excavation only in locations where it cannot enter sensitive aquatic resources.
m) Minimize alteration or disturbance of the stream banks and existing riparian vegetation to the greatest extent possible.
n) Remove undesired vegetation and root nodes by mechanical means only. No herbicide application shall occur.
o) Mark and identify clearing limits. Construction activity or movement of equipment into existing vegetated areas shall not begin until clearing limits are marked.
p) Retain all existing vegetation within 46 meters (150 feet) of the edge of the bank to the greatest extent practicable.

4. To implement RPM #4, RC, FERC and the ACOE must require the Trust to do the following:
    a) Contact NMFS (Jeff Murphy (Jeff.Murphy@noaa.gov or (207) 866- 7379) **and** incidental.take@noaa.gov) within 24 hours of any interactions with Atlantic sturgeon, shortnose sturgeon, or Atlantic salmon including non-lethal and lethal takes.
    b) In the event of any lethal takes, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS.
    c) Submit annual reports at the end of each calendar year summarizing the results of proposed action and any takes of listed species to NMFS by e-mail (incidental.take@noaa.gov).

5. To implement RPM #4, the FERC, RC, and the ACOE must require the Trust to do the following:
    a) Monitor ambient water temperatures in the lower Penobscot River from April 1st to June 30th annually to analyze the success of turbine shutdowns. Annual reports summarizing water temperature monitoring should be submitted to resource agencies by August 1st annually during the period of interim operations.
    b) Require the Trust to develop a dam and fish bypass maintenance and operation plan for the Howland Project in consultation with state and federal resource agencies.
    c) Develop an invasive plant species monitoring and removal plan for the projects.
    d) Evaluate upstream and downstream passage for Atlantic salmon and shortnose sturgeon following dam removal in consultation with state and federal fisheries agencies.
    e) Monitor the mouths of tributaries in the former impoundments to ensure effective passage for migratory fish species.

6. To implement RPM #4, the FERC, RC, and the ACOE must require the Trust to do the following:
    a) Monitor the effectiveness of the Howland fish bypass in passing Atlantic salmon upstream and downstream for three years. Upstream studies will focus on adults while downstream studies will focus on smolts and kelts. The methods and scope of effectiveness studies should be developed in consultation with various state and federal resources agencies. Annual reports summarizing the results of the studies should be submitted to resource agencies by January 1st of each year during the three-year period.
    b) Monitor the physical integrity of the Howland fish bypass for 15 years. The methods and scope of monitoring should be developed in consultation with various state and federal resources agencies. Annual reports summarizing the results of the monitoring should be submitted to resource agencies by January 1st of each year during the 15-year period.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, reinitiation of consultation and review of the reasonable and prudent measures are required. FERC, RC, and ACOE must immediately provide an explanation of the causes of the taking and review with NMFS the need for possible modification of the reasonable and prudent measures. Specifically, these RPMs and Terms and Conditions will keep NMFS informed of when and where construction activities are taking place and will require the Trust to report any take in a reasonable amount of time. These RPMs and Terms and Conditions also require the Trust to conduct water temperature and fish passage monitoring and to conduct pre-construction meetings. The RC, FERC and ACOE, as well as the applicants, have reviewed the RPMs and Terms and Conditions outlined above and all parties have agreed to implement all of these measures as described herein. The discussion below explains why each of these RPMs and Terms and Conditions are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed action and how they represent only a minor change to the action as proposed by the FERC, RC, and ACOE.

RPM #1, #2, and #3 as well as Terms and Conditions #1-3 are necessary and appropriate as they will require that the Trust and their contractors use best management practices and best available technology for the dam removals. This will ensure that take of listed Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon is minimized to the extent practical. These procedures represent only a minor change to the proposed action as following these procedures should not increase the cost of the project or result in any delays or reduction of efficiency of the project.

RPM #4 as well as Terms and Conditions #4-6 are necessary and appropriate to ensure the proper documentation of any interactions with listed species as well as requiring that these interactions are reported to NMFS in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. This RPM and the Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the project.

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has determined that the proposed action is not likely to jeopardize the continued existence of federally listed shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon in the action area. As this project is intended to conserve and restore populations of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon, NFMS is not recommending any further conservation recommendations in this Opinion.

12. REINITIATION NOTICE

This concludes formal consultation concerning the Restoration Center’s re-initiation of consultation for the approval to surrender licenses and dam removals at the Veazie and Great Works Projects and surrender license and construct a fish bypass at the Howland Project located on the Penobscot and Piscataquis Rivers in Penobscot County, Maine. As provided in 50 CFR §402.16, re-initiation 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.

This opinion assumes that interim operations will occur for no more than three years. If interim operations are required for a period greater than three years, RC, FERC or the ACOE must reinitiate consultation with NMFS.

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