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NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency:	Federal Energy Regulatory Commission (FERC)
Activity Considered:	Surrender of Licenses for the Veazie, Great Works and Howland Projects, Nos. 2403, 2312, 2721 F/NER/2009/01515
Conducted by:	National Marine Fisheries Service Northeast Region
Date Issued:	Dec 23, 2009
Approved by:	

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1. INTRODUCTION AND BACKGROUND

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543) concerning the effects of the Federal Energy Regulatory Commission's (FERC or Commission) approval of applications to surrender licenses and decommission via dam removals at the Veazie (FERC No. 2403) and Great Works (FERC No. 2312) Projects and surrender license and construct a fish bypass at the Howland Project (FERC No. 2721) located on the Penobscot and Piscataquis Rivers in Penobscot County, Maine. On November 7, 2008, FERC received an application from the Penobscot River Restoration Trust (Trust) to surrender the project licenses for the Veazie, Great Works, and Howland Projects pursuant to the terms of the Lower Penobscot River Basin Comprehensive Settlement Accord (Settlement)[1]. 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 to FERC 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.

In addition to FERC, several federal agencies are taking actions to authorize, fund or carry out the removal of the Veazie and Great Works Projects and construction of the fish bypass at the Howland Project including the U.S. Army Corps of Engineers (ACOE), NOAA's Restoration Center (NOAA RC), and the U.S. Fish and Wildlife Service (FWS). The ACOE proposes to authorize the proposed actions pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for wetlands impacts and fill associated with the projects[2]. Using funds allocated under the 2009 American Recovery and Reinvestment Act, NOAA RC proposes to award approximately $5 million to the Trust for dam removal activities associated with the Great Works Project. Additionally, FWS is proposing to issue funds to the Trust. Pursuant to the Section 7 regulations (50 CFR §402.07), when a particular action invovlves more than one Federal agency, the consultation responsibilities may be fulfilled through a lead agency. FERC is the lead Federal agency for the proposed actions under consideration in this consultation. A complete administrative record of this consultation will be maintained by the NMFS's Maine Field Office in Orono, Maine.

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1 The Lower Penobscot River Multiparty Settlement Agreement (MPA) was signed by PPL Maine LLC, the U.S. Department of the Interior {acting through its Fish and Wildlife Service, Bureau of Indian Affairs, and the National Park Service}, four State of Maine natural resource agencies {the Maine State Planning Office, Department of Marine Resources, Department of Inland Fisheries and Wildlife, and Atlantic Salmon Commission), the Penobscot Indian Nation, American Rivers, Atlantic Salmon Federation, Maine Audubon, Natural Resources Council of Maine, Trout Unlimited, and the Penobscot River Restoration Trust. The Nature Conservancy joined the Trust after the MPA was filed with FERC on June 25, 2004.

2 The ACOE has received permit applications from the Trust. A Public Notice outlining the proposed action and soliciting public comments was issued by ACOE on September 15, 2009. The ACOE project number is NAE 2003-2462.

1.1. Consultation History

November 7, 2008. The Trust's application was submitted to FERC.

January 8, 2009. The Trust requested to be the FERC's non-federal representative for informal Section 7 consultation.

February 17, 2009. Representatives from the Trust met in Orono, Maine with USFWS and NMFS to discuss preparation of the draft Biological Assessment (BA).

March 23, 2009. Letter from Trust to NMFS requesting updated species lists for purposes of carrying out informal Section 7 consultation and preparation of draft BA.

April 3, 2009. Letter from NMFS to Trust containing updated species list and guidance on preparation of draft BA.

April 13, 2009. Representative from the Trust met in Orono, Maine with NMFS to discuss content of draft BA.

June 9, 2009. Representatives from the Trust met in Gloucester, Massachusetts with NMFS 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 NMFS and USFWS to discuss draft BA.

June 22, 2009. Representatives from the Trust met in Orono, Maine with NMFS and USFWS to discuss operations of the Projects prior to dam removal.

August 12, 2009. FERC requested formal consultation with NMFS under Section 7 of the ESA for decommissioning of the Veazie, Great Works, and Howland Projects.

September 3, 2009. NMFS 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.

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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 12 and are cited directly throughout the body of the document. Primary sources of information include: 1) information provided in the FERC's August 12, 2009 initiation letter and attached BA in support of formal consultation under the ESA; 2) rule designating Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (*Salmo salar*) in the Gulf of Maine (65 FR 69459; Nov. 17, 2000); 3) Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006); 4) Determination of Endangered Status for the Gulf of Maine Distinct Population Segment of Atlantic salmon; Final Rule (74 FR 29345; June 19, 2009); 5) Designation of Critical

Habitat for Atlantic salmon Gulf of Maine Distinct Population Segment (74 FR 29300; June 19, 2009); and 6) Final Recovery Plan for Shortnose Sturgeon (December, 1998).

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, NMFS takes 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);
- 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 5);
- Determines and evaluates any cumulative effects within the action area (Section 6); 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 7).

In completing the last step, NMFS determines 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, NMFS 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, NMFS 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

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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 and remove the dams and associated works of the Veazie Project and Great Works Project and to surrender the license and construct a fish bypass channel around the Howland Project. On January 6, 2009, FERC issued an order transferring the licenses for the three projects to the Trust, subject to the Trust taking title to the projects. The Trust proposes decommissioning the three projects, two of which would be removed (Veazie and Great Works). At Howland, the dam would remain and the Trust would construct a fish bypass channel to allow free passage of migratory fish from below the project to the impoundment. The following section describes the existing hydroelectric facilities and proposed decommissioning activities.

2.1. Existing Hydroelectric Facilities and Operations

2.1.1. 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 FERC license issued on April 20, 1998 for a term of 40 years. The dam creates an impoundment that extends upstream for 3.8 miles and covers 390 surface acres. The Veazie spillway consists of a 64-ft-long gravity concrete segment near its left abutment and a main 487-ft-long concrete buttress segment with a maximum height of 32 ft. Other structural features include a 230-ft-long masonry forebay wall, two fishways, and a 65-ft-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 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 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 7,500 cfs, all water passes through the powerhouses. When inflows are more than 7,500 cfs, all units are on-line and water in excess of

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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.

2.1.2. Great Works Project

The Great Works Project is located approximately 7 miles upstream of the Veazie Dam and approximately 2 miles downstream of the Milford Hydroelectric Project (Figure 1). The project is contained within the towns of Old Town, Bradley and Milford located in Penobscot County. The project has operated under an annual FERC license since the original license expired on March 31, 2002. The dam creates a 128-acre impoundment which extends 1.7 miles upstream to the Milford project. The dam was built in the late 1800s.

The Great Works Dam is approximately 1,020 feet long and consists of five separate sections of stone masonry, concrete gravity and timber crib. The tailrace is separated from the main river by an earthen dike, and the powerhouse discharges to the tailrace. The presence of the earthen dike creates a 1,200 ft long bypass reach. The Project also includes two operating Denil-type fish ladders, one located in the tailrace, the other at the west end of the spillway. An older, abandoned fish ladder is located near the center of the spillway. A bypass weir for passing downstream migrating diadromous fish is also present at the project. The powerhouse contains 11 turbine-generator units with a total installed capacity of approximately 7,655 kW. The project is operated as a run-of-river facility with a total hydraulic capacity of 8,640 cfs. A 40" diameter water supply intake that provides process water to an adjacent mill (Red Shield Mill) is also present at the project; however, this intake is not under the jurisdiction of FERC.

2.1.3. Howland Project

The Howland Project is located on the Piscataquis River, approximately 500 ft 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 270 surface acre impoundment that is 4.7 miles in length.

The Howland Dam consists of a 114.5-ft-long concrete cutoff wall at the north embankment of the dam, a 6-ft-long non-overflow abutment, a 570–ft-long concrete overflow spillway, an 85-ft-long section containing a gated spillway section with four 9-by-9-ft steel roller flood gates, a 20-ft-long non-overflow spillway, and a 76-ft-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 1,710 cfs.

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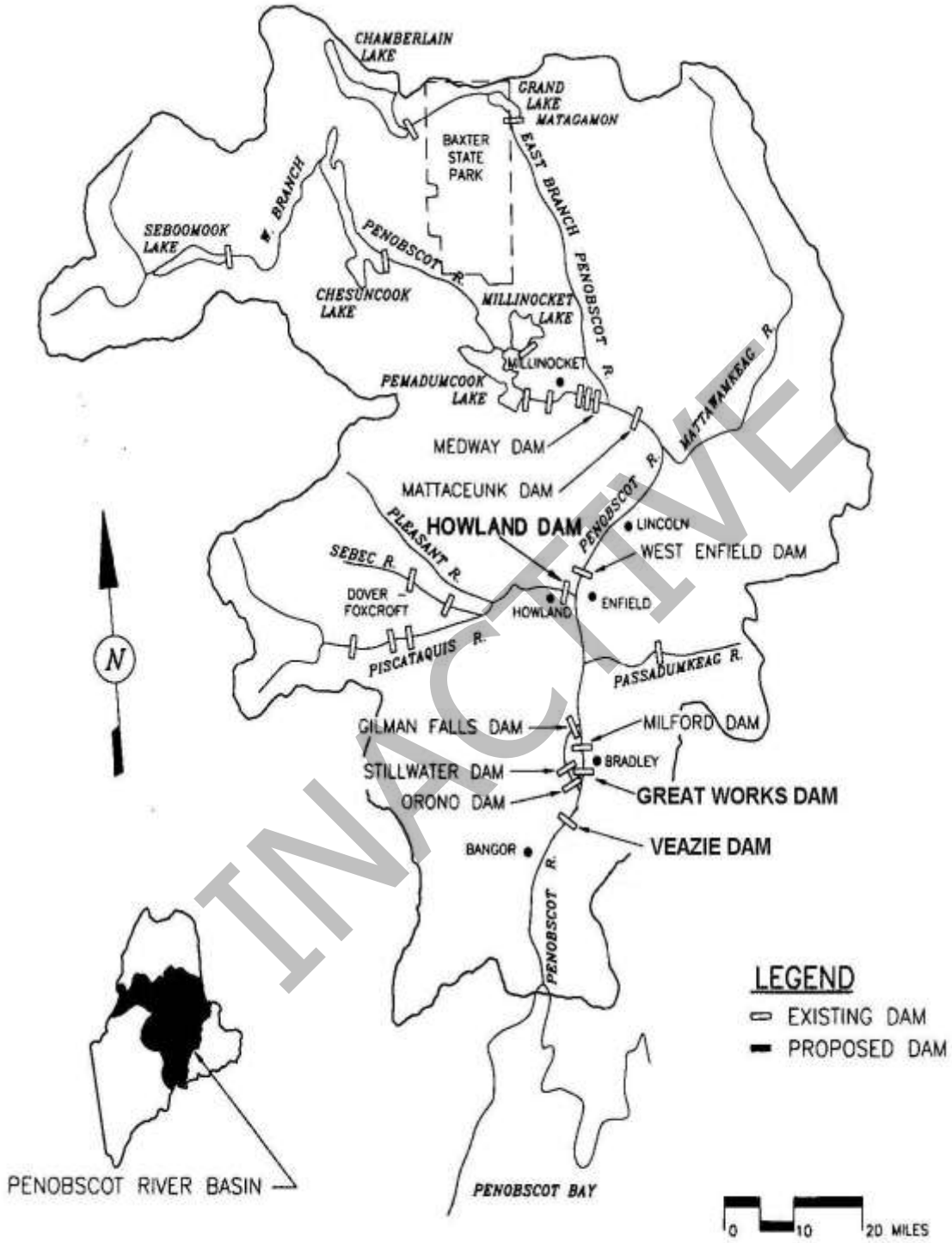
Figure 1. Penobscot River Watershed (Source: Trust 2008)



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2.2. Proposed Action

The Trust proposes to decommission the Veazie, Great Works, and Howland Projects in stages. Prior to decommissioning activities, the Trust proposes to continue operating the projects until sufficient funds have been raised to allow removal and other construction activities to occur.

2.2.1. Pre-Removal Activities

In 2008, the Trust acquired sufficient funds to purchase the Veazie, Great Works, and Howland Projects from PPL Maine, LLC. The Trust estimates that an additional $25 million will be needed to complete the decommissioning and removal activities including construction of the Howland fish bypass. The Trust has already secured significant funding toward decommissioning costs including $900,000 in implementation funds from NOAA, $5 million from NOAA's RC under the 2009 American Recovery and Reinvestment Act, and $300,000 from the USFWS' National Fish Passage Program. The Trust intends to generate funds for project implementation during pre-removal activities by operating the hydroelectric facilities between the period of closing and dam decommissioning. It is presently unknown how long the Trust will need to operate the projects prior to raising sufficient funding for decommissioning. Sufficient funds have been raised for the removal of the Great Works Project so any period of interim operations at Great Works should be short (likely 2 years). Based on the best available information and for purposes of this Opinion, NMFS assumes that interim operations at the Veazie and Howland Projects will occur for no longer than 6 years prior to decommissioning.

Currently, all three projects are operated pursuant to the terms and conditions of existing FERC licenses (see above). After the Trust acquires title to the three dams, and prior to decommissioning and removal of the dams, the dams will be operated by the Trust in accordance with existing FERC license articles. Existing FERC license articles require the projects to be operated in a run-of-river mode with minimal impoundment fluctuations.

As a result of preliminary discussions with USFWS and NMFS, the Trust intends to implement turbine shutdowns in the spring, after acquisition of the dams but prior to dam removal, to improve aquatic habitat and streamflow conditions for resident and anadromous species, including shortnose sturgeon and Atlantic salmon. Although these measures do not require FERC approval, the Trust intends to implement such measures to facilitate, to the greatest extent practicable, the purpose and goals of the Trust's restoration project. As such, operation of the facilities with these modifications will be considered as part of the proposed action. The proposed turbine shutdowns at the facilities will be 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; Great Works: 10 of 11; Howland: 2 of 3

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2.2.2. Decommissioning Activities

2.2.2.1.Overview

According to the Trust, decommissioning and dam removal construction activities at all three projects will require two to three construction seasons. While initiation of construction is dependent upon the Trust receiving final regulatory approvals from the FERC, ACOE, the State of Maine, and the Trust securing the funds to carry out the construction work, decommissioning and removal activities could begin as early as 2010. The Trust proposes to remove the Great Works Dam first. This will allow for upstream migrating salmon to be captured at the downstream Veazie Dam and trucked to an upstream location to avoid impacting the species during construction activities at Great Works. Removal of the Great Works Dam should require only one construction season. 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 has yet to develop its final design for removal of Veazie and Great Works Dams, 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), and Fort Halifax (FERC No. 2552) Projects in Maine. Details on access road construction, sediment and erosion control, and revegetation procedures were included in the Trust's surrender applications, and are attached to the FERC's BA. As such, these are considered as part of the proposed action. The timing of construction of the fish bypass at the Howland Project will likely occur during summer low flows, but is not restricted by removals of the Veazie and Great Works Projects. Timelines depicting all phases of construction work at the three projects are contained in FERC's BA and included as Appendix A of this Opinion. Appendix B includes the construction drawings illustrating the steps to be taken during each phase of the project.

Prior to dam removal activities at the Veazie and Great Works Projects, each impoundment will be lowered to reduce the amount of instream work and to facilitate access to project structures. The initial draw-down phases at the Veazie and Great Works Dam can proceed as soon as flows in the Penobscot River drop in the summer to around 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 Project 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 at the dams 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 and shortnose sturgeon, the Trust proposes to commence dam removal activities at the Veazie Dam after July 1st of any given year. Since adult salmon will be transported around the Veazie Dam during construction activities and smolt migrations occur in early spring, the Trust will likely commence removal of the Great Works Dam in June or July once rivers flows are between 6,000 – 7,000 cfs.

The following provides specific descriptions of the proposed decommissioning plans at each

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project. As explained above, work will proceed in stages with the removal of the Great Works Dam occurring first, followed removal of the Veazie Dam and construction of the bypass at Howland.

2.2.2.2.Veazie Project

Under the proposed action, the Trust will decommission the Veazie Project, 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 20.5 ft 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 instream 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. For the Veazie Dam removal, it is anticipated that 15,000 cubic yards of temporary fill covering an area approximately 12.27 acres be will placed in the Penobscot River. 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.

Overview of Removal Activities

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

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subsurface soundings, these remnants are believed to be comprised of a dam across about 1/3 of the river up to 20 ft high connected to a 1,900 ft longitudinal wing dam extending parallel to flow approximately 240 feet upstream of the east side of the powerhouse forebay. The structure is presently submerged under five to nine feet of water.

Due to its likely effect on future hydraulic conditions, the upstream remnant dam structure is proposed to be removed. This will require access roads and 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 8,700 cubic yards of concrete (much of which is likely to be reinforced) and approximately 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.

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 (see Figure 6 of 19 in Appendix):

1. open all powerhouse gates to drawdown the pool (approximately 2 weeks);
2. lower/deflate the flashboard system;
3. construct the eastern bank access road along an existing unpaved accessway. This road will extend to the abandoned fishway structure on the eastern shore;
4. remove the gravity section of the dam;
5. remove east bank cableway towers and cables, with footings to remain;
6. extend the east bank access road upstream and along the backside of the dam, to 320 feet from the eastern extent of the maximum buttress section;

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7. extend the east bank access road downstream along the face of the dam to create a temporary access road approximately 20 feet wide and extending approximately 450 feet from the shore;
8. breach the easternmost section of the spillway (approximately 320 feet long) and remove the spillway from west to east; and,
9. if necessary, regrade 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, 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.

<u>Phase III – West Bank Dam, Forebay, and Powerhouse B Removal</u> – 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 (see Figure 7 of 19 in Appendix). Phase III will include the following activities:

1. extend the west bank access road approximately 700 feet from the shoreline into the river upstream of the dam;
2. remove the forebay, tailrace tunnel walls, gates and powerhouse B;
3. remove the existing fishway;
4. remove the spillway from east to west;
5. if necessary, regrade the channel at the dam for fish passage;
6. remove any remnants of the old cofferdam present between the access road and the dam; and,
7. 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.

<u>Phase IV – West Bank Site Improvements</u> – Following the removal of the west portion of the spillway, west bank site improvements will begin (see Figure 8 of 19 in Appendix). In this stage the west bank access road will be extended along the face of the powerhouse (adjacent to the

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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 the Veazie removal project will involve the removal of the remnant mill dam (see Figures 9, 10 and 11 of 19 in Appendix). Steps to be completed under this phase are:

1. construct access road along exposed east bank to upstream of perpendicular dam section. The access road will extend approximately 1000 feet along the shoreline and then extend approximately 375 feet towards the middle of the river;
2. remove the perpendicular section of the remnant dam from west to east;
3. remove the east bank access road;
4. construct access road extending approximately 375 feet from the west bank and remove section of the dam structure accessible from this road;
5. construct T-shaped access road from west bank and remove section of the dam structure accessible from this road;
6. construct additional section of west bank access road and remove section of the dam structure accessible from this road;
7. remove any old structures (i.e., piers, etc) from the upstream pool areas as needed;
8. implement landscape restoration plans and remove west bank access roads; and,
9. remove debris boom and excess debris.

Construction of the east bank access road where it extends towards the middle of the river will not occur in the dry and rock fill will be deposited into wetted portions of the river. 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.

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2.2.2.3. Great Works Project

Under the proposed action, the Trust will decommission the Great Works Project, disconnect the generator units from the grid, and remove the gate and spillway sections of the dam, the vegetated embankment adjacent to the powerhouse, and existing fishways. The Trust does not propose to remove the existing powerhouse but will partially fill and grade the forebay channel immediately upstream of the powerhouse and the tailrace dike to facilitate downstream passage of fish and naturally occurring debris. Removing the spillway dam will lower the impoundment elevation approximately 12.6 ft during the August median flow near the dam.

To complete the project, the Trust will need to place temporary and permanent fill in the Penobscot River to facilitate construction/demolition access. Approximately 11,864 cubic yards of temporary fill will be needed to facilitate removal of the Great Works Dam. All temporary fill will be removed at the site. Approximately 12,650 cubic yards of permanent fill will be placed at the Great Works Project to facilitate fish and naturally occurring debris movements at the site. Temporary fill will serve as both access roads and cofferdams to isolate discrete work areas.

Overview of Removal Activities

Spillway and Abutments – The five spillway segments at the Great Works Project will be removed as well as two nine-foot diameter sluice gates and one six-foot diameter sluice gate adjacent to the powerhouse. The east abutment of the dam is a sheetpile and earthen embankment on the east river bank in the Town of Bradley. The sheetpile and earthen embankment will remain.

Powerhouse – The powerhouse structure at the Great Works Project is located along the west bank of the Penobscot River. Removal of the powerhouse is likely to create a vertical barrier to fish passage. Additionally, the powerhouse contains electrical services and control panels for an adjacent mill complex. For these reasons, the powerhouse will not be removed.

Forebay Area – The forebay upstream of the powerhouse could potentially act as a trap for logs and other natural debris following removal of the spillway. This area will be regraded and partially filled to result in a more uniform shoreline to facilitate downstream movements of floating debris and fish.

Tailrace and Dike – A tailrace dike extends approximately 900 feet downstream of the powerhouse and separates the tailrace from the main river channel. The dike is generally situated on a small island next to the main river composed of artificial fill. The tailrace channel bottom is about four to five feet lower than the elevation of the main channel bed. An analysis of tailrace hydraulic dynamics likely to follow dam removal concluded that the tailrace will not present a significant deterrent or delay to upstream fish passage. Therefore, the Trust does not propose to remove the tailrace dike.

Upstream Dam Remnants – Remnants of an old dam structure are submerged upstream of the Great Works Project. The structure is "V" shaped, pointing upstream, with two long lateral (underwater) spillways parallel to each bank and a deeper log sluice channel and gates between the spillways. The dam is submerged under 1-4 ft of depth. Side scan sonar data collected by CR Environmental, Inc. indicates that the submerged dam remnants are not continuous. Based upon previous field investigations and available data, the Trust believes that these remnants will not pose a hydraulic or physical barrier to upstream fish migration, nor are they expected to be a significant impediment to recreational use of the river in this location. Therefore, the Trust does not propose to remove these dam remnants. However, the Trust will evaluate the status of fish passage at this structure after the pool is drawn down to determine whether future modification will be needed. In addition, approximately 12 log crib, stone, and concrete piers that were formerly used to capture and sort logs are still in place along the west side of the Great Works Project. These structures will also remain in place.

Upstream Ice-Break Piers – A number of piers located approximately 230 feet upstream of the spillway are present to break up ice in the river. The piers are 20 to 25 feet square and protrude approximately 10 feet above the water under existing conditions. The piers are stone masonry with concrete caps and are likely constructed of filled timber crib below the waterline. The piers are not significant flow obstructions due to their size and spacing. As such, these piers will not be removed.

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Fishways – The Great Works Project is equipped with two active Denil-type fishways (one near the powerhouse and one near the masonry spillway segment against the side of the dam), as well as a third obsolete fishway near the middle of the spillway. The powerhouse Denil fishway is constructed of concrete and approximately 230 feet long and 4 feet wide. This fishway is located immediately upstream of the tailrace dike. Free-standing sections of the fishway adjacent to the powerhouse will be removed. Fishway sections integral to the powerhouse structure will remain. At the tailrace dike, the fishway will be filled with concrete or stone and graded over to prevent future potential breaches of the dike. The remaining two fishways will be completely removed.

Disposal of Materials – The Great Works Project spillway is composed of five distinct sections. Three sections are timber crib, one is stone masonry, and one is concrete. Construction debris will consist of concrete, stone fill, and large timber. Removal of the dam will generate approximately 3,600 cubic yards of concrete and 19,500 cubic yards of stone fill and wood cribbing. 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 reused.

Detailed Work Plan

Phase I – Site Preparation – In this phase, the turbines will be removed from the powerhouse and the water supply intake to the Mill will be replaced[3]. Temporary road access will be prepared from the east bank of the river, along with establishment of erosion controls and staging areas. The existing floating boom upstream of the dam will be modified to catch debris and logs and a downstream debris boom will be installed.

Phase II – Water Control and East Bank Fishway Removal – During the second phase of construction, the powerhouse gates and turbines will be opened to draw down the impoundment. The sluice gates and bypass pipes will also be opened and flashboards will be removed (if in place at the time) to create dry conditions along the central and eastern portions of the spillway.

Impoundment drawdown is anticipated to last two to three weeks. During this phase of work, the fish ladder will no longer be functional. An access road will be constructed from the eastern bank and then the fishway structure will be removed from mid-channel. This phase of work is anticipated to last for three to four weeks.

Phase III – East Bank Dam Removal – Under this phase, spillway section B will be removed from west to east using the east bank access road. Following this phase of drawdown, spillway sections C, D, and E will be removed from west to east. Some clean granular material may be reused to fill and shape the powerhouse forebay. The river bed under and near the spillway will be inspected and modified if needed to eliminate any remaining vertical fish passage barriers. This phase is anticipated to last for twelve weeks.

Phase IV – West Bank Dam Removal – In phase IV, the west bank access road will be constructed and the final spillway section (Section A) will be removed, along with the spillway gates, the fishway adjacent to spillway section A, and artificial fill associated with the small

[3] While relocation of the mill's intake will be necessary, this action is outside of the jurisdiction of FERC and effects of the proposed relocation will not be considered in this Opinion.

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island adjacent to the tailrace dike. The forebay area will be partially filled and graded, as will the area around the northwestern edge of the powerhouse. Upon completion, the access road will be removed, moving from east to west, with portions incorporated into the forebay fill. This phase is anticipated to last twelve weeks.

2.2.2.4.Howland Project

Under the proposed action, the Trust will decommission the Howland Project, 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 8-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 3.8 feet 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 700 feet in length with an average base width of 75 feet and a low flow channel typically 12 to 25 feet wide. Flow to the bypass will be controlled through 8 bays (box culverts) with stoplogs. 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 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. Topsoil 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.

Overview of Surrender Activities

<u>Dam, Flashboards, and Gates</u> – 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 eight-foot 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.

<u>Buildings</u> – 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.

<u>Fish Bypass</u> – A fish bypass will be constructed around the Howland Project to allow upstream

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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 100 feet downstream (east) of the powerhouse. The fish bypass exit (which is the hydraulic inlet) will be located 600 feet 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 for 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 planting. 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.

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2.2.3. Decommissioning Period Protective/Mitigation Measures

The purpose of the PRRP and this proposed action is to restore diadromous fish species to the Penobscot River watershed. Nevertheless, decommissioning 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

- 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 regrading 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 3 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.

Great Works

- Remove the Great Works Dam prior to the Veazie Dam to allow adult Atlantic salmon passage around the work area during construction activities. Adult salmon trapped at Veazie will be either transported to the hatchery or trucked upstream of the Great Works

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Dam;

- 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;
- Plan the timing of construction activities in consultation with natural resource agencies;
- Provide for effective fish passage by regrading 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 3 years after dam removal that incorporates creating temporary and permanent vegetative cover, where necessary;
- Reduce generation by turning off 10 of the total11 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

- 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[4];
- 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 3 years after flashboard removal that incorporates creating temporary and permanent vegetative cover, where necessary;

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4 The Howland Dam may be removed if monitoring over a 15-year period indicate that the fish bypass is not achieving safe, timely, or efficient passage of migratory fish species.

- 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 2 of the total 3 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.

2.2.4. Post-Decommissioning Actions

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 drawdowns 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; and 4) placement of stone riprap at the base of existing walls as a splash pad. These activities will require a permit from the ACOE under the Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. As noted above, the Trust has applied for the appropriate authorizations from the ACOE and the ACOE is proposing to issue these permits.

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.

Decommissioning of the Veazie, Great Works, and Howland Projects is expected to affect much of the Penobscot River Salmon Habitat Recovery Unit (SHRU) which encompasses the range of shortnose sturgeon in the Penobscot River. Short-term, construction related effects are expected to occur largely in the lower Penobscot River from the Howland Dam downstream to below the Veazie Dam. However, long-term beneficial effects of the project are expected to occur throughout the Penobscot River SHRU through improved connectivity, increased marine derived nutrient exchange, prey buffering, and improved water quality conditions. Therefore, the entire Penobscot River SHRU represents the action area for this consultation.

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3. RANGEWIDE STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

This section will focus on the status of listed species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action on listed species. Federally-listed species known to occur in the Penobscot River watershed include the Gulf of Maine Distinct Population Segment (DPS) of Atlantic salmon (*Salmo salar*) and shortnose sturgeon (*Acipenser brevirostrum*). Both species are listed as endangered under the ESA. Additionally, this section will provide information on the status of critical habitat designated for the GOM DPS of Atlantic salmon.

3.1. Gulf of Maine DPS of Atlantic Salmon

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

The Gulf of Maine (GOM) Distinct Population Segment (DPS) of anadromous Atlantic salmon was initially listed by the USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). A subsequent listing as an endangered species by the Services (74 FR 29344; June 19, 2009) included an expanded range for the GOM DPS of Atlantic salmon. The decision to expand the geographic 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 (BRT) consisting of federal and state agencies and Tribal interests. Fay *et al.* (2006) concluded that the DPS delineation in the 2000 listing designation was largely appropriate, except in the case of large rivers that were excluded in the 2000 listing determination. Fay *et al.* (2006) concluded that the salmon currently inhabiting Maine's 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/or 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) concluded that this group of populations (a "distinct population segment") met both the discreteness and significance criteria of the Services' DPS Policy (61 FR 4722; Feb. 7, 1996) and, therefore, recommended the geographic range included in the new expanded GOM DPS. The final rule expanding the GOM DPS agreed with the conclusions of BRT regarding the DPS delineation of Maine Atlantic salmon.

The newly listed 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

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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 Hatcheries (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).

3.1.1. Species Description

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 ocean and migrate to their natal stream to spawn. 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 5 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. 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/gravel substrate needed for spawning and consequently reduce egg survival (Gibson 1993). As the female deposits eggs in the redd, one or more males fertilize the eggs (Jordan and Beland 1981). The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel.

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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 2 sea-winter (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum and Meister 1971). After spawning, Atlantic salmon may either return to sea immediately or remain in freshwater until the following spring before returning to the sea (Fay et al. 2006). From 1967 to 2003, approximately 3 percent of the wild and naturally reared adults that returned to rivers where adult returns are monitored--mainly the Penobscot River--were repeat spawners (USASAC 2004).

Embryos develop in the redd 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 6 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 4 cm 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 2 to 3 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 (4 to 7 cm long), whereas second and third year parr are characterized as large parr (greater than 7 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 Resier 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; Erkinaro et al. 1998; Halvorsen and Svenning 2000; Hutchings 1986; O'Connell and Ash 1993; Erkinaro et al. 1995; Dempson et al. 1996; Klemetsen et al. 2003).

In a parr's second or third spring (age 1 or age 2 respectively), when it has grown to 12.5 to 15 cm in length, a series of physiological, morphological, and behavioral changes occur (Schaffer and Elson 1975). This process, called "smoltification," prepares the parr for migration to the

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ocean and life in salt water. In Maine, the vast majority of naturally reared parr remain in freshwater for 2 years (90 percent or more) with the balance remaining for either 1 or 3 years (USASAC 2005). In order for parr to undergo smoltification, they must reach a critical size of 10 cm 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 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, 2005). Kocik et al. (2009) documented smolt migrating with the tides primarily at night. 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, 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) and/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°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 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).

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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 non-maturing 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 Rangewide

The abundance of Atlantic salmon within the range of the GOM DPS has been generally declining since the 1800s (Fay *et al.* 2006). Data sets tracking adult abundance are not available throughout this entire time period; however, Fay *et al.* (2006) present a comprehensive time series of adult returns to the GOM DPS dating back to 1967. 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).

Contemporary abundance estimates are informative in considering the conservation status of the GOM DPS today. After a period of population growth in the 1970s, adult returns of salmon in the GOM DPS have been steadily declining since the early 1980s and appear to have stabilized at very low levels since 2000 (Figure 2). 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. Poor marine survival persists in the GOM DPS to date.

Adult returns to the GOM DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Further, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounted for 91 percent of all adult returns to the GOM DPS in 2007. Of the 1044 adult returns to the Penobscot in 2006, 996 of these were the result of smolt stocking and only the remaining 48 were naturally-reared. A total of 916 and 2,117 adult salmon returned to the Penobscot River in 2007 and 2008, respectively. Most of these returns were also of hatchery origin (USASAC 2008). The term naturally-reared includes fish originating from natural spawning and from hatchery fry (USASAC 2008). Hatchery fry are included as naturally-reared because hatchery fry are not marked; therefore, they cannot be distinguished from fish produced through natural spawning. Because of the extensive amount of fry stocking that takes place in an effort to recover the GOM DPS, it is possible that a substantial number of fish counted as naturally-reared were actually stocked as fry.

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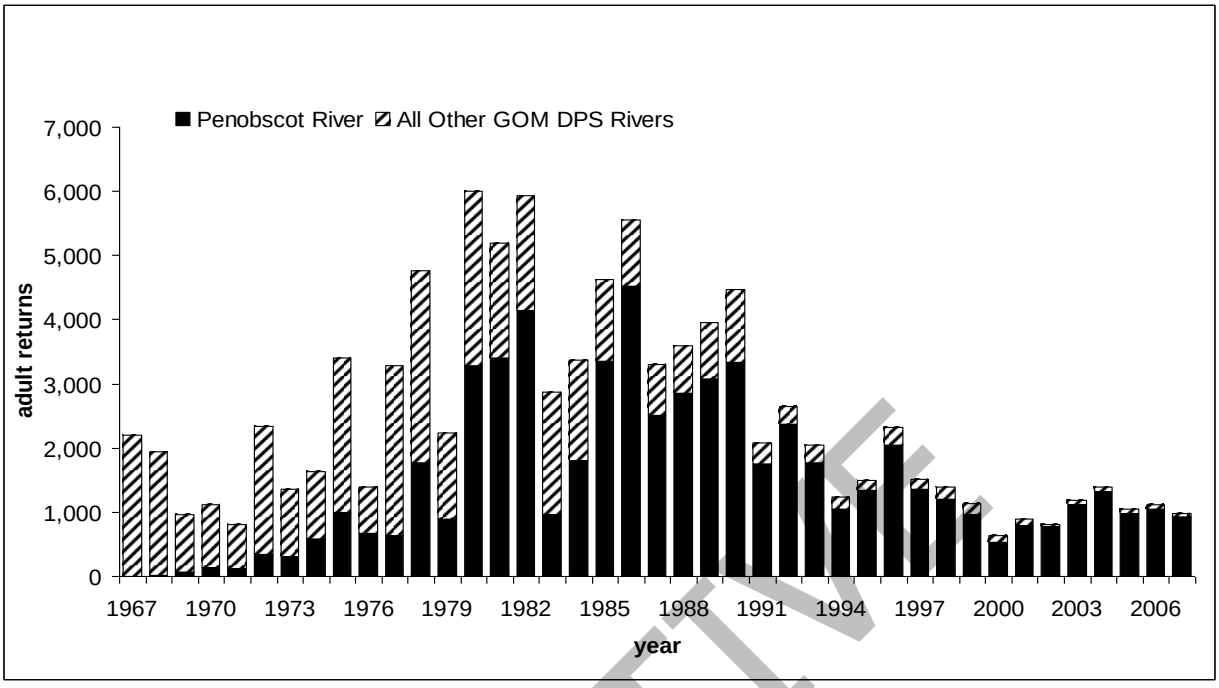
Figure 2. Adult returns to the GOM DPS 1967-2007.



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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 hatcheries. In short, hatchery production over this time period has been relatively constant, generally fluctuating around 550,000 smolts per year (USASAC 2008). In contrast, the number of naturally reared smolts emigrating each year is likely to decline following poor returns of adults (three years prior). Thus, wild smolt production would suffer three years after a year with low adult returns, because the progeny of adult returns typically emigrate three years after their parents return. The relatively constant inputs from smolt stocking, coupled with the declining trend of naturally reared adults, result in the apparent stabilization of hatchery-origin salmon and the continuing decline of naturally reared components of the GOM DPS observed over the last two decades.

Adult returns for the GOM DPS remain well below conservation spawning escapement (CSE) goals that are widely used (ICES 2005) to describe the status of individual Atlantic salmon populations. When CSE goals are met, Atlantic salmon populations are generally self-sustaining. When CSE goals are not met (i.e., less than 100 percent), populations are not reaching full potential; and this can be indicative of a population decline. For all GOM DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below CSE levels required to sustain themselves (Fay *et al.* 2006), which is further indication of their poor population status.

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 10%) 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.

3.1.3. Critical Habitat

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 3). 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[5]). 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.

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

<u>Physical and Biological Features of the Spawning and Rearing PCE</u>

A1. 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.
A2. 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.
A3. 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.
A4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
A5. 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.
A6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.
A7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

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5 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.

Physical and Biological Features of the Migration PCE

B1. 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.

B2. 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.

B3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.

B4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

B5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration

B6. 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 has only been designated in areas 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 and therefore requiring special management considerations or protections include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road crossings, mining, dams, dredging, and aquaculture.

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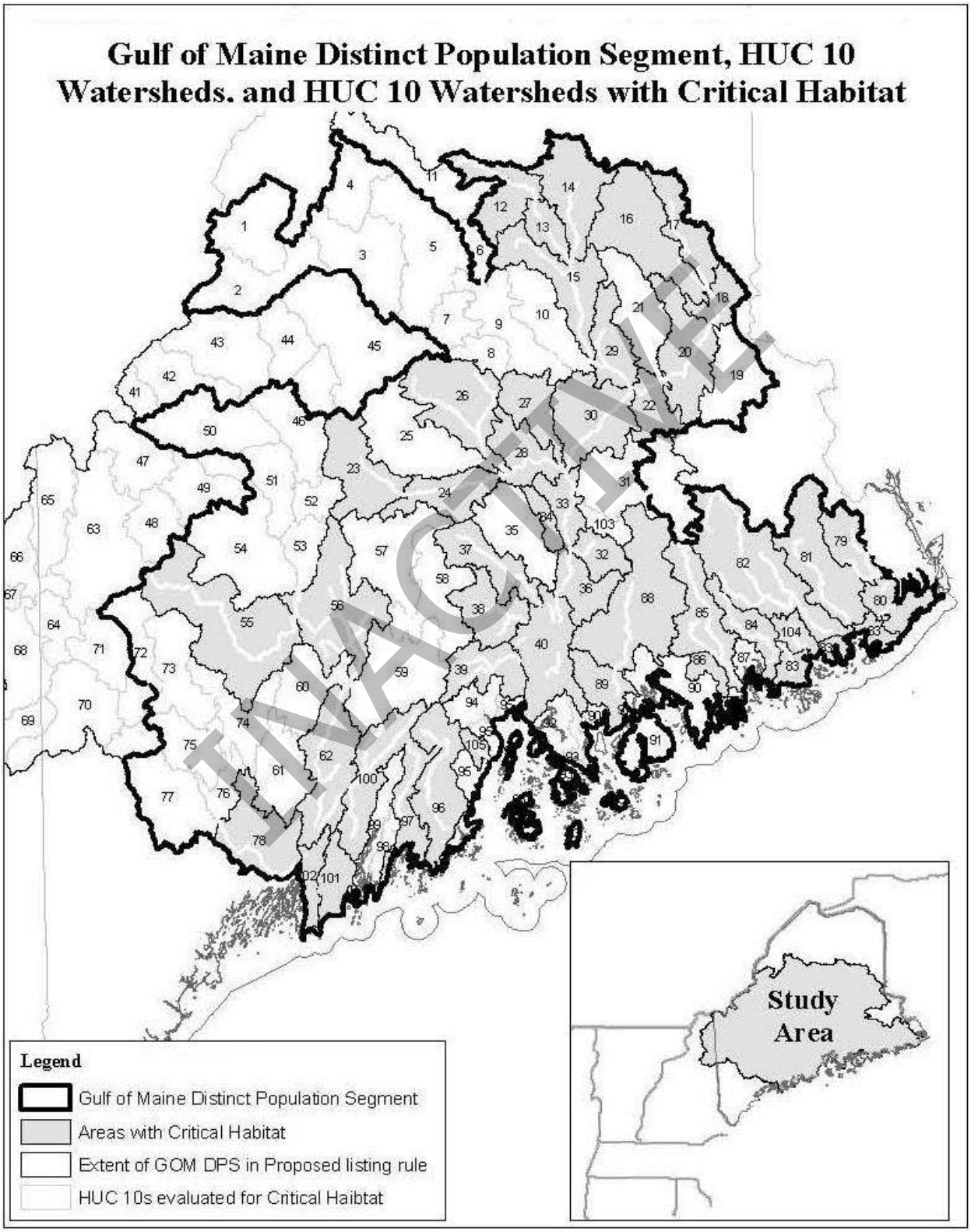
Figure 3. HUC 10 watersheds designated as Atlantic salmon critical habitat within the GOM DPS.



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Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

In describing critical habitat for the Gulf of Maine DPS, NMFS divided the GOM DPS into three Salmon Habitat Recovery Units or SHRUs. The three SHRUs are the Downeast Coastal, Penobscot Bay, and Merrymeeting Bay. The SHRU delineations were designed by NMFS to ensure that a recovered Atlantic salmon population has widespread geographic distribution to help maintain genetic variability and, therefore, a greater probability of population sustainability in the future. Areas designated as critical habitat within each SHRU are described in terms of habitat units. One habitat unit represents 100 m^2 of suitable salmon habitat (which could be spawning and rearing habitat or migration habitat). Habitat units within the GOM DPS were estimated through the use of a GIS-based salmon habitat model (Wright *et al.* 2008). Additionally, NMFS discounted the functional capacity of modeled habitat units in areas where habitat degradation has affected the PCEs. For each SHRU, NMFS determined that 30,000 fully functional units of habitat are needed in order to achieve recovery objectives for Atlantic salmon. Brief historical descriptions for each SHRU, as well as contemporary critical habitat designations and special management considerations, are provided below.

Penobscot Bay SHRU

The Penobscot Bay SHRU, which drains approximately 22,234,522 hectares (54,942,705 acres), contains approximately 323,700 units of historically accessible spawning and rearing habitat for Atlantic salmon among approximately 17,440 km of rivers, lakes and streams. Of the 323,700 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)(Table 1). Of the 211,000 occupied units within the Penobscot SHRU, NMFS calculated these units to be the equivalent of nearly 66,300 functional units or approximately 20 percent of the historical functional potential. This estimate is based on the configuration of dams within the SHRU that limit migration and the degradation of physical and biological features from land use activities which reduce the productivity of habitat within each HUC 10. The combined qualities and quantities of habitats available to Atlantic salmon within the currently occupied areas in the Penobscot Bay SHRU currently meet the objective of 30,000 fully functional units of habitat available to Atlantic salmon. 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, although the Penobscot Nation specifically requested that their reservation lands be included as critical habitat.

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Table 1. List of HUC 10 watersheds within the Penobscot River watershed.

HUC Code	Watershed Name	Habitat Units	Habitat Quality[6]	Functional Equivalent
105000219	Ducktrap River	862	2	575
102000510	Kenduskeag Stream	6,869	2	4,579
102000512	Marsh River	6,018	2	2,899
102000205	East Branch Penobscot River	15,843	3	7,029
105000218	Belfast Bay	2,245	2	919
102000506	Penobscot River at Orson Island	5,278	2	2,161
102000401	Piscataquis River	18,914	3	7,133
102000302	East Branch Mattawamkeag River	3,973	2	1,383
102000406	Piscataquis River	9,669	2	3,365
102000404	Pleasant River	22,346	2	7,776
102000301	West Branch Mattawamkeag River	11,290	2	3,929
102000513	Penobscot River	10,876	1	3,625
102000511	Souadabscook Stream	5,507	1	1,836
102000203	East Branch Penobscot River	6,355	2	1,880
102000501	Penobscot River at Mattawamkeag	3,408	2	1,008
102000204	Seboeis River	7,442	2	2,201
102000202	Grand Lake Matagamon	5,740	2	1,443
102000509	Penobscot River at Veazie Dam	7,550	1	1,818
102000507	Birch Stream	1,065	1	218
102000505	Sunkhaze Stream	2,335	1	478
102000503	Passadumkeag River	7,950	1	1,500
102000502	Penobscot River at West Enfield	14,098	1	2,453

In conclusion, the June 19, 2009 final critical habitat designation for the GOM DPS includes 45 specific areas occupied by Atlantic salmon that comprise approximately 19,571 km of perennial river, stream, and estuary habitat and 799 square km 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 which may require special management consideration. Within the occupied range of the GOM DPS, approximately 1,256 km of river, stream, and estuary habitat and 100 square km of lake habitat have been excluded from critical habitat pursuant to section 4(b)(2) of the ESA.

3.1.4. Summary of Factors Affecting Recovery of Atlantic Salmon

The recovery plan for the previously designated GOM DPS (NMFS and USFWS 2005) and the most recent status review (Fay *et al.* 2006) as well as the 2009 listing rule, provide a comprehensive assessment of the many factors, including both threats and conservation actions, currently impacting listed Atlantic salmon.

[6] 0 = no habitat, 1=25th percentile of habitat quality within SHRU, 2=50th percentile of habitat quality within SHRU, and 3= highest habitat value.

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Efforts to Protect the GOM DPS and its Critical Habitat

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

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

A wide variety of activities have focused on protecting Atlantic salmon and restoring the GOM DPS, including (but not limited to) hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to Atlantic salmon and developing effective restoration strategies. In light of the 2009 GOM DPS listing and designation of critical habitat, the Services will produce a new recovery plan for the expanded GOM DPS of Atlantic salmon.

Threats to Atlantic Salmon Recovery

A threats assessment performed as part of the 2005 recovery plan resulted in the following list of high priority threats requiring action to reverse the decline of GOM DPS salmon populations:

- Acidified water and associated aluminum toxicity, which decrease juvenile survival
- Aquaculture practices, which pose ecological and genetic risks
- Avian predation
- Changing land use patterns (e.g., development, agriculture, forestry)
- 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
- Low marine survival
- Poaching of adults in DPS rivers
- Recovery hatchery program (potential for artificial selection/domestication)

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- Sedimentation of spawning and rearing habitat
- Water extraction

It is important to note that this analysis was conducted for the species as listed in 2000 and therefore did not include the Atlantic salmon population throughout the Androscoggin, Kennebec and Penobscot Rivers.

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

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

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

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

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

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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.

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 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 SHRU because it provides a central migratory corridor crucial for the entire Penobscot 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 SHRU. A combined total of twenty FERC-licensed hydropower dams in the Penobscot 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 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 below the Great Works Dam.

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

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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.

3.2. Shortnose Sturgeon

Shortnose sturgeon are listed throughout their range. As such, the status of the species as a whole will be discussed below. Additionally, information specific to the Penobscot River population of shortnose sturgeon, which occurs in the action area, will be discussed in more detail.

3.2.1. Species Description

Shortnose sturgeon life history
Shortnose sturgeon are benthic fish that are primarily found in the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including molluscs, 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 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers) when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species with delayed 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

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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 limited recruitment information available for shortnose sturgeon. 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 develop 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 (3-10 years old) 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 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 a river (Kieffer and Kynard 1993). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1993). Squiers *et al*. (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 (1993) 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 C, 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). The eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.* 1984). Between 8º 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.

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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). 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 and Weber 1994; Rogers and Weber 1995; Weber 1996). Limited information is currently available on the extent and frequency of coastal migrations made by individual shortnose sturgeon; however, at least some limited coastal migrations between adjacent rivers occur.

The temperature tolerance for shortnose sturgeon is not well known (Dadswell *et al.* 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (Dadswell *et al.* 1984) and as high as 34ºC (Heidt and Gilbert 1978). However, temperatures above 28ºC are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 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 0.6m is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m but are generally found in waters less than 20m (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; Saunders and Smith 1978). Mcleave *et al.* (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 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 are present (Gilbert 1989).

3.2.2. Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication,

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

Although shortnose sturgeon are listed as endangered range-wide, the final recovery plan recognizes 19 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)[7] of shortnose sturgeon under the ESA. Life history studies, combined with available genetic information, indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1998). 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, shortnose sturgeon populations in these 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

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

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

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

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

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This could account for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is less likely that this river will be recolonized. Consequently, this Opinion will treat the Penobscot River population of shortnose sturgeon separately from the other eighteen identified populations of shortnose sturgeon with their range for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations

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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 (fish move between fresh and salt water during some part of life cycle, but not for breeding)(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 St John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1998, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1998 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

3.2.3. 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. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel *et al.* 1992; Collins *et al.* 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely

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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 (Johnson *et al.* 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).

Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term, repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979). In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). Coal tar deposits are known to be present in the Penobscot River.

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

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pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

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. According to the Recovery Plan for shortnose sturgeon (NMFS 1998) low oxygen levels (below 5 mg/L) are known to be stressful to aquatic life, and presumably, sturgeon would be adversely affected by levels below this limit. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (Flourney *et al.* 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

4. ENVIRONMENTAL BASELINE OF THE ACTION AREA

The Environmental Baseline provides a snapshot of a species health or status at a given time within the action area and is used as the biological basis upon which to analyze the effects of the proposed action. Assessment of the environmental baseline includes an analysis of the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this biological opinion includes the effects of several activities that may affect the survival and recovery of the endangered species in the action area. The activities that shape the environmental baseline in the action area of this consultation generally include: hydroelectric operations, water quality impacts, scientific research, commercial and recreational fisheries, and recovery activities associated with reducing those impacts.

Decommissioning of the Veazie, Great Works, and Howland Projects is expected to affect much of the Penobscot River Salmon Habitat Recovery Unit (SHRU), which represents the action area for this consultation. While short-term, construction related effects will affect the lower Penobscot River, long-term beneficial effects will occur throughout the SHRU. The Penobscot River watershed is the largest drainage basin lying entirely within the State of Maine and the second largest in New England. Located in central Maine between the watersheds of the Saint John River to the north, the St. Croix River to the east, and the Kennebec River to the west, it covers an area of 8,570 square miles, a maximum length (north-south) of about 125 miles, and a maximum width of about 115 miles, nearly one-quarter of the entire state (Figure 1).

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The Piscataquis River, a major tributary to the Penobscot, represents approximately 17 percent of the Penobscot River watershed (Trust 2008). The Piscataquis River sub-basin comprises a drainage area of approximately 1,500 square miles. The sub-basin is approximately 65 miles long and 40 miles wide (Trust 2008) and is located in the western central portion of the Penobscot River basin (Figure 1).

The Veazie Project is the lowermost dam on the Penobscot River, which is tidally influenced to the base of the dam (Figure 1). The Great Works Project is located approximately 7 miles above Veazie Dam and approximately 2 miles downstream of the Milford Project. The drainage area at Great Works is 7,680 square miles, or 90% of the total watershed drainage. The Howland Project is located on the Piscataquis River, approximately 500 ft upstream of its confluence with the Penobscot River, and roughly 33 miles north of Bangor. The contributing drainage area above the Howland Project is approximately 1,500 sq miles.

4.1. Gulf of Maine DPS of Atlantic Salmon

4.1.1. Status of the Species and Critical Habitat in the Action Area

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section 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 500,000 smolts are stocked in the Penobscot River watershed annually. In addition, over 2 million fry and parr are stocked in the Penobscot River watershed annually. Of these fish, about 175,000 smolts and 150,000 parr are distributed to the Piscataquis River watershed. As such, all lifestages of Atlantic salmon could be present in the action area of this consultation.

<u>Upstream migrating adults</u>

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 2,115 in 2008 (Table 1)(MDMR 2008). The majority of adult returns to the Penobscot River are of hatchery origin (Fay et al. 2006).

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Table 1. Total Atlantic salmon collected at the Veazie Trap during 2000-2008.

Year	Total Atlantic Salmon Collected
2000	534
2001	785
2002	780
2003	1112
2004	1323
2005	985
2006	1045
2007	916
2008	2115
2009	1958

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 differed greatly in 2007 and 2008, the monthly breakdown and median capture dates were similar (Table 2)(MDMR 2007, 2008).

Table 2. Monthly total and median capture dates of Atlantic salmon collected at the Veazie Trap during 2007-2009.

Month	2007	2008	2009
May	48	267	173
June	458	1465	1382
July	268	236	370
August	79	111	14
September	45	18	11
October	18	15	8
Total run	**916**	**2115**	**1958**
Med. capture date	**23 June**	**26 June**	**18 June**

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 rarely achieved. Table 3 below presents broodstock targets and number of broodstock collected at the Veazie Dam since 2000.

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Table 3. Total Atlantic salmon broodstock collected at the Veazie Trap during 2000-2009.

Year	Broodstock Target	Total Broodstock Collected	Date of Last Broodstock
2000	600	328	07/21/00
2001	600	502	07/21/01
2002	600	377	07/29/02
2003	600	605	07/31/03
2004	600	606	06/23/04
2005	600	475	09/07/05
2006	650	537	09/02/06
2007	650	590	09/02/07
2008	650	650	06/16/08
2009	650	679	7/5/2009

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 Great Works and Howland, 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).

Adult returns are not monitored in the Piscataquis River on an annual basis. However, in 2002, a PIT tag study by Gorsky (2005) detected approximately 110 salmon in the lower Piscataquis drainage. In 2004, 34 redds were detected in the river by the MDMR. The number of adult Atlantic salmon returning to the Piscataquis River is variable and may be proportional to the overall number of fish passed at the Veazie Project fishway.

<u>Post-spawned adults</u>

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 1989b, Hall and Shepard 1990b). 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.

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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 4). 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.

Freshwater residents in the project areas

Atlantic salmon utilize free-flowing rivers and streams for spawning and juvenile rearing. The lake-like condition of the impoundments at the Veazie, Great Works and Howland projects do not provide suitable spawning or rearing habitat for Atlantic salmon. Some spawning and/or rearing habitat does exist immediately below the Veazie and Great Works Projects. Little or no suitable rearing habitat exists downstream of the Howland Project.

State fishery agencies recently estimated juvenile Atlantic salmon production in the Penobscot watershed, using habitat surveys and suitability modeling (MDMR, 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, MDIFW 2009).

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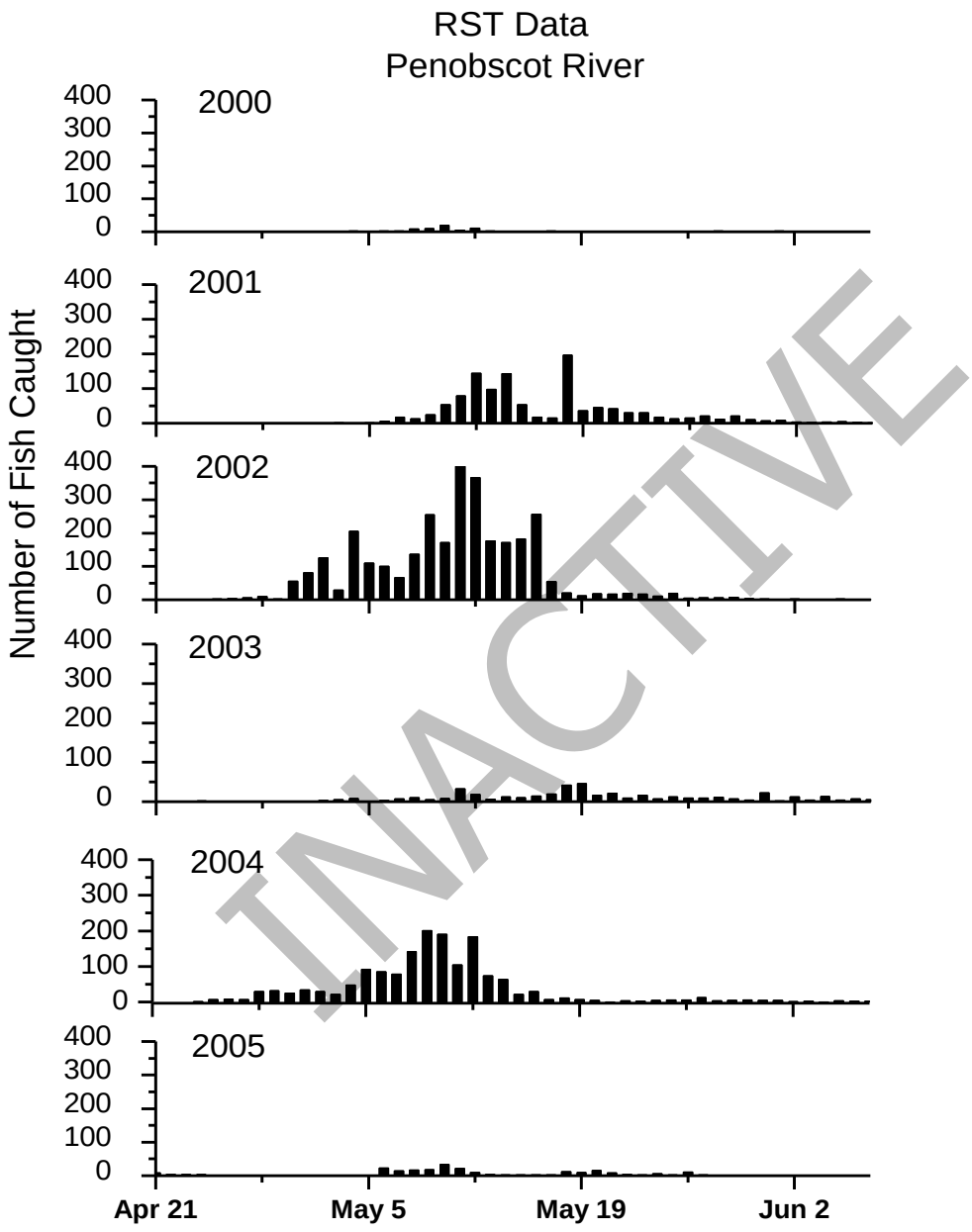
Figure 4. Total number of smolts collected using rotary screw traps in the Penobscot River from 2000 to 2005.



Critical Habitat

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 primary constituent elements (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 in Section 3.1.3, critical habitat for Atlantic salmon has been designated in the Penobscot and Piscataquis Rivers. Both PCEs for Atlantic salmon (sites for spawning and rearing and sites for migration) are present in the action area of this consultation. 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, NMFS developed the “Matrix of PCEs and Essential Features for Designated Atlantic Salmon Critical Habitat in the GOM DPS” (Table 4). The matrix lists the PCEs, physical and biological features (essential features) of each PCE, and the potential conservation status of critical habitat within an action area. The 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 5).

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Table 4. Matrix of Primary Constituent Elements (PCEs) and \and essential features for assessing the environmental baseline of the action area.

		Conservation Status Baseline		
PCE	Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
A) Adult Spawning: (October 1st - December 14th)				
	Substrate	highly permeable course gravel and cobble between 1.2 to 10 cm in diameter	40- 60% cobble (22.5-256 mm dia.) 40-50% gravel (2.2 – 22.2 mm dia.); 10-15% course sand (0.5 -2.2 mm dia.), and <3% fine sand (0.06-0.05mm dia.)	more than 20% sand (particle size 0.06 to 2.2 mm), no gravel or cobble
	Depth	17-30 cm	30 - 76 cm	< 17 cm or > 76 cm
	Velocity	31 to 46 cm/sec.	8 to 31cm/sec. or 46 to 83 cm/sec.	< 5-8 cm/sec. or > 83cm/sec.
	Temperature	7° to 10^oC	often between 7° to 10^oC	always < 7° or > 10^oC
	pH	> 5.5	between 5.0 and 5.5	< 5.0
	Cover	Abundance of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Limited availability of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Absence of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
B) Embryo and Fry Development: (October 1st - April 14th)				
	Temperature	0.5^oC and 7.2^oC, averages nearly 6oC from fertilization to eye pigmentation	averages < 4oC, or 8 to 10^oC from fertilization to eye pigmentation	>10^oC from fertilization to eye pigmentation
	D.O.	at saturation	7-8 mg/L	< 7 mg/L
	pH	> 6.0	6 - 4.5	< 4.5
	Depth	5.3-15cm	NA	<5.3 or >15cm
	Velocity	4 – 15cm/sec.	NA	<4 or > 15cm/sec.

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

TABLE 4 continued…

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

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TABLE 4 continued…

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

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Table 5. Current condition 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

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4.1.2. Factors Affecting Atlantic Salmon in the Action Area

4.1.2.1. 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 100,000 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 (1997a) 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 1997a). 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 1996a).

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).

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Habitat Connectivity

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 MASC 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 1989a, Shepard and Hall 1991, Shepard 1995). Shepard (1995) hypothesized that warm water temperatures during certain study years contributed to some of the low passage success rates observed at Veazie.

At Great Works Dam, upstream passage success for adult Atlantic salmon ranged from 38% in 1990 to 95% in 1989, and averaged 81% over five years of study (Dube 1988, Shepard 1989a, Shepard and Hall 1991, Shepard 1995). At Milford Dam, the next dam upstream, upstream passage success ranged from 86% in 1987 to 100% in 1990, and averaged 90% (56 of 62) over five years of study (Dube 1988, Shepard 1989a, Shepard and Hall 1991, Shepard 1995). At the West Enfield Project, located 20 river miles upstream of Milford, upstream passage success was at least 90% over several years of study. 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%. The disparity between the telemetry results seen at individual dams could be the result of differing river flows or operational conditions during testing.

In 2005 and 2006, Holbrook (2007) performed 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. Cumulative passage success of adult salmon past five dams in the lower Penobscot River was 38% in 2005 and 8% in 2006. The dams studied were Veazie, Great Works, Milford, Howland, and West Enfield. The lowest recorded passage success occurred at Great Works which in 2005 was 50% and in 2006 was 12%.

In addition to upstream passage success information, these radio tag studies collectively report a wide range in time needed for individual adult salmon to pass upstream of various dams 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). Upstream passage delays at Great Works and Milford Dams 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). Passage delays for adult salmon observed at Milford were similar to those observed at Great Works (Shepard 1995). Due to small sample sizes, varying release locations among study years, and other experimental design factors, cumulative upstream passage success for the lower three dams on the Penobscot River (Veazie, Great Works, and Milford) is difficult to extract from these radio tag studies. However, in 1988 and 1989, respectively, 40% and 63% of study fish that were available below the Veazie Dam successfully passed both Veazie and Great Works Dams (Shepard 1995). Applying the average passage success of 90% over five years of site-specific study at Milford (see above), one could grossly estimate the three-dam passage success rate at 36% in 1988 and 57% in 1989.

The 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

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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 Weldon 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 Weldon 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.

Beland and Gorsky (2004) also reported a significant percentage of adult Atlantic salmon (15 to 24%) that, once reaching the vicinity of either the West Enfield Dam on the main stem or the Howland Dam at the mouth of the Piscataquis River (located within one river mile of each other), passed both fishways at least once prior to selecting a final course and continuing further upstream. Recognizing that part of this apparent indecision could in part be a natural result of salmon encountering a major hydrological division in the watershed, it may also be due in part to the presence of two artificial barriers in the immediate vicinity.

Downstream passage success of smolts have also been studied at dams in the Penobscot River watershed. Two hydropower projects on the Penobscot, Mattaceunk (fifth main stem dam above tidewater) and West Enfield (fourth main stem dam above tidewater), have received the most site-specific study among all dams within the range of the GOM DPS. Most of these studies were conducted by project licensees and used radio telemetry. At the Mattaceunk Project, passage efficiency of the downstream fishway for hatchery smolts, over seven years of study in the 1990s, ranged from 17% to 59% (GNP 1989, GNP 1995, GNP 1997, GNP 1998, GNP 1999). Virtually all other study fish passed this dam via turbines, as there was no spill during any of the study periods. Passage efficiency of the downstream fishway for wild smolts ranged from 28% to 37% (GNP 1995, GNP 1997). At the West Enfield Dam, downstream passage collection efficiencies for hatchery smolt over five years of study in the early 1990s ranged from 2% to 49% (Bangor-Pacific Hydro Associates (BPHA) 1993a, 1993b, 1994; Hall and Shepard 1990a; Shepard 1991a, 1991b). Downstream passage efficiency for wild smolts was 14% in one year of study (BPHA 1994). Most other passages at this dam were via turbines, although 8% in 1990 and 28% in 1991 passed via the spillway.

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 main stem dams (Milford, Great Works, Veazie) and the intervening habitat was between 30.5% and 61% (Shepard 1991c). 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 main stem 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 1991c), 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.

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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).

Spicer et al. (1995) investigated long distance survival of smolts in the Penobscot. Of 32 radio-tagged hatchery smolts released below the Howland (Piscataquis) and West Enfield dams, only one was recorded as reaching and passing the first downstream dam encountered (Milford), about 33 km from the release site. Short battery life of radio transmitters and predation may have contributed to the loss of test fish during the study.

The potential for delays in the timely passage of smolts encountering hydropower dams is also evident in some of these 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 1993b), and approximately 13 hours (range 0.2 to 102.9 hours) for wild smolts in 1994 (BPHA 1994). 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).

Downstream passage success of kelts has also been assessed in the Penobscot (GNP 1989, Shepard 1989b, Hall and Shepard 1990b). 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, and a large portion of study fish used the spillage, success over main stem 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 main stem), kelts followed the routes in approximate proportion to flow in the two channels. Shepard (1989) 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.

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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 smolt 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 that 60% were the result of entrainment (USASAC 2004). Injuries attributed to turbine entrainment were also noted on smolts collected alive during the studies.

Dams on the Penobscot River are known to impede migrations of other diadromous fish species including alewives, shad, American eel, and sea lamprey. The linkage between other diadromous fish species and Atlantic salmon may be crucial to recovering Atlantic salmon to self-sustaining levels (Fay et al. 2006). It is believed that co-evolutionary factors between salmon and other diadromous fish species likely provided ecological benefits including marine derived nutrients and prey buffering to the diadromous species complex. Thus, the lack of adequate fish passage for other diadromous fish species in the Penobscot River may be furthering impacting Atlantic salmon in the Penobscot River.

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4.1.2.2. 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 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 (a major tributary of the Penobscot) 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.

4.1.2.3.Conservation and Recovery Actions

In November 2005, NMFS and the USFWS issued the Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (NMFS and USFWS 2005). The major areas of action in the recovery plan are designed to stop and reverse the downward population trends of Atlantic salmon populations and minimize the potential for human activities to result in the degradation or destruction of Atlantic salmon habitat essential to survival and recovery.

4.2. Shortnose Sturgeon

4.2.1. Status of the Species 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).

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-

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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. A total of 185 shortnose sturgeon were captured in the river in 2008 and 221 in 2009. All sturgeon captured during the study were adults or large juveniles as the type of gear used for sampling (large mesh gill nets of 6" and 12" stretch) is not designed to capture sturgeon less than 2 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 population size. The Peterson estimate of shortnose sturgeon abundance was 1,425 with a confidence interval of 203-2647. The Schnabel estimate was 1,531 with a confidence interval of 885-5681. 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. However, researchers believe that these estimates, particularly the Lincoln/Peterson Index, are a reasonable first attempt at an estimate and represents the best available information at this time. Researchers are currently exploring other models that do not have assumptions related to closed populations; however, other population estimates are not currently available.

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). Movement into and out of the Penobscot River estuary also was documented, including immigration into the Kennebec River estuary where there is a large population of shortnose sturgeon (Fernandes 2008).

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, ME DMR, 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.

Based on recaptures of tagged fish, the shortnose sturgeon population in the Penobscot was estimated to be modest is size, ranging from several hundred to a few thousand individuals (Fernandes 2008). Telemetry studies indicate that while shortnose sturgeon are present in the

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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 2 km (1.2 mi.) 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 mile 36.4) and an asphalt plant in Bangor (river mile 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. Tracking data indicate that sturgeon begin moving into this reach of the Penobscot River in October and depart in early spring (April). Some adults start moving back into the vicinity of this area in June. This information indicates that the area between 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.* 2006). 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.

Based on life history information from other rivers, adult shortnose sturgeon in the Penobscot River 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 1-5m with water velocity between 50-125 cm/s and cobble/rubble substrate (101-300 mm diameter).

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. When water temperatures drop to 10°C in the fall, shortnose sturgeon move to upstream overwintering areas. In some river systems (Hudson, Connecticut), overwintering areas are segregated between spawners and non-spawners. In the Penobscot River, the distance to be traveled to the spawning grounds is relatively short and there may only be one overwintering area 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

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4 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 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, larvae, young-of-year, juvenile, and adult shortnose sturgeon have the potential to occur in the action area at various times of the year. These lifestages would only occur downstream of the Veazie Dam. Based on historic water temperatures and residency time, larval sturgeon are expected to occur in the action area from April through June. Based upon data collected by UM, over-wintering sturgeon are likely to occur in the Bangor area from October to April.

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 University of Maine studies (Fernendes 2008).

Moving upstream from the Bangor section of the river, the river bottom becomes much more armored, consisting of boulders, cobble and rubble (Trust 2008). Bathymetric surveys conducted by the Trust in support of its applications for license surrender showed negligible amounts of silt, sand or other fine sediments immediately below the Veazie Dam. While spawning by shortnose sturgeon could hypothetically occur over the harder substrates found immediately below Veazie Dam, spring movements from the overwintering grounds by tagged fish to these potential upstream spawning sites have not been documented. While no tagged shortnose sturgeon have been detected within 2km of the Veazie Dam, this is thought to be due to interference with the tags and receivers which would make movements in this 2km reach undetectable. Additional modeling by University of Maine researchers showed that 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).

Recent data collected by UMaine and ME DMR indicate that migration between river systems is more extensive than was previously thought. Many tagging and telemetry studies in rivers throughout the species' range indicated that shortnose sturgeon remain in their natal river or the river's estuary (Dadswell *et al.* 1984, NMFS 1998).

Sonic transmitters were implanted in a total of thirty-nine shortnose sturgeon from June 14, 2006 through September 27, 2007 in the Penobscot River by UMaine; however this total includes tags that were expelled or in individuals who may have suffered mortality (S. Fernandes, UMaine, pers. comm. 2008). Eleven of these sturgeon have been subsequently detected in the Kennebec River by ME DMR with its passive array of receivers. It is approximately 70 km between the

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mouth of the Kennebec River and the mouth of the Penobscot River. One tracked individual traveled 230 km from its tagging site in Bangor on the Penobscot River to upper Kennebec River (S. Fernandes, UMaine, pers. comm. 2007). Additionally, movement from the Kennebec to the Penobscot was documented when two shortnose sturgeon PIT tagged by ME DMR in the Kennebec River in 1998 and 1999 were recaptured in the Penobscot River in 2006 by UMaine researchers

Ultrasonic transmitters were implanted in five pre-spawning adult shortnose sturgeon in late September 2007 in the Bangor/Brewer overwintering area on the Penobscot River (S. Fernandes, UMaine, pers. comm. 2007). The intent was to track these individuals the following spring to locate the spawning area(s) in the Penobscot River. ME DMR subsequently detected four of these pre-spawning adults with its passive array of receivers in the Kennebec River in October and November 2007. Four of these five sturgeon were subsequently located in the Kennebec River overwintering area near rkm 38 in February 2008. These sturgeon were located from approximately rkm 37.25 to 39.25. In addition, a fifth shortnose sturgeon implanted with a transmitter during the same time period and area was located in the Kennebec River overwintering area.

ME DMR deployed its passive array of receivers in early April 2008. Four of the five Penobscot shortnose sturgeon located in the Kennebec River overwintering grounds in February 2008 were tracked. These four were females with late stage eggs. One migrated upriver to the Farmingdale/Hallowell (rkm 61) reach in the Kennebec River which had been previously identified by ME DMR as a spawning area. Another migrated to Waterville (rkm 97) which is the upstream limit of sturgeon habitat and was made accessible with the removal of the Edwards Dam in 1999. A third migrated to the known spawning area on the Androscoggin River near Brunswick, ME (rkm 44). These three moved rapidly downriver after a few days and are presumed to have left the Kennebec River system. The fourth sturgeon with late stage eggs migrated to the mouth of the Androscoggin and was last located in Merrymeeting Bay on May 12, 2008. Its signal was not picked up on any of the downriver receivers.

In addition to the Penobscot females with late stage eggs, an additional three Penobscot River shortnose sturgeon outfitted with acoustic transmitters in 2006 were located in the Kennebec River in the spring of 2008. Penobscot sturgeon with code 13 arrived at Townsend Gut on May 10, 2008 and migrated through the Sasanoa River to the Kennebec River and arrived in the Farmingdale/Hallowell reach on May 20, 2008. Townsend Gut is a tidal channel connecting the Sheepscot River and Boothbay Harbor. It was never subsequently picked up on any of the Kennebec River receivers. Penobscot sturgeon with code 115/116 was located in the Merrymeeting Bay overwintering area in the Kennebec River on April 16, 2008 and migrated to the Eastern River arriving on April 19, 2008. It migrated rapidly downriver to the Sasanoa River arriving on April 25, 2008 and was located in the Phippsburg area from April 25 to May 19, 2008. It then migrated upriver to the Farmingdale/Hallowell reach of the Kennebec River on May 21, 2008 and remained for only two days. It was subsequently picked up in Phippsburg on May 24, 2008 and was last recorded on May 28, 2008. Penobscot sturgeon with code 117/118 was recorded at Townsend Gut on May 12, 2008. It was never subsequently picked up on any of the Kennebec River receivers.

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Research has been conducted by the NYU 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. The most recent estimate of the number of shortnose sturgeon in the Kennebec complex is 9888 and successful spawning has been confirmed in both the Kennebec and Androscoggin Rivers.

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 is currently ongoing on the Penobscot River samples; however, no results are available to report at this time.

As noted above, the Lincoln/Peterson Index estimate of 1,049 adult shortnose sturgeon (Fernandes et al. 2008) is the best available estimate of the number of shortnose sturgeon present in the Penobscot River at a given time. 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 a Schnabel estimate of 9888 adults (Squiers 2003). 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.

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4.2.2. Factors Affecting Shortnose Sturgeon in the Action Area

4.2.2.1.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 100-200km 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 prevents shortnose sturgeon from accessing historically available habitat above the Dam, which is thought to have extended to at least Milford Falls (approximately rkm 70). The Veazie Dam has 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. While shortnose sturgeon do not currently occur above the Veazie Dam, to the extent that upstream hydroelectric projects affect conditions below Veazie Dam, shortnose sturgeon are affected by the operation of these projects as well.

4.2.2.2.Contaminants and Water Quality

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 and may also impact the health of 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 shortnose sturgeon are particularly vulnerable. In 2000, the US Environmental Protection Agency (EPA) delegated authority for the National Pollutant Discharge Elimination System (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.

Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term, repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979). Contaminant analysis of tissues from a shortnose sturgeon from the Kennebec River (which supports similar industries, such as paper mills, as the Penobscot River) revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). Thomas and Khan (1997) demonstrated that exposure to cadmium at concentrations well below the concentration detected in the shortnose sturgeon significantly increased ovarian production of estradiol and testosterone which can adversely affect reproductive function. The concentration of zinc detected in the shortnose sturgeon liver tissue was slightly less than the effect concentration for reduced egg hatchability reported by Holcombe *et al.* (1979) and exceeded the effect concentration for reduced survival cited in Flos *et al.* (1979).

Ruelle and Henry (1994) 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 are not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. PCBs may also contribute to a decreased immunity to fin rot. 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

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weight, fish fork length, and DDE (dichlorodiphenyldichloroethylene) concentration in pallid sturgeon livers indicates that DDE increase proportionally with fish size (NMFS 1998).

Despite improvements to water quality in the Penobscot River, discharges to this system contribute various chemical contaminants as well as heated effluent to the river. As noted above, the watershed is considered impaired for fish consumption and recreational uses. The cumulative effects of discharges into the river is unknown and may be negatively impacting or delaying the potential for shortnose sturgeon to recover in this system

4.2.3. Conservation and Recovery Actions

In 1998, NMFS issued the Final Recovery Plan for shortnose sturgeon (NMFS 1998). The long-term recovery objective for shortnose sturgeon is to recover all populations to levels of abundance at which they no longer require protection under the ESA. To achieve and preserve minimum population sizes for each population segment, the final recovery plan recommends identifying and preserving essential habitats, monitoring and minimizing mortality, and protecting shortnose sturgeon through applicable federal and state regulations. Conservation and recovery actions in the action area have been limited to scientific studies (see below).

4.3. Scientific Studies

UM was issued a scientific research permit (No. 1595) by NMFS in 2007 which authorizes the capture of up to 100 shortnose sturgeon annually in the Penobscot from 2007-2012 using gill nets and trammel nets. This permit has been modified several times, most recently on March 2, 2009. 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, NMFS concluded that the research to be authorized under Permit No. 1595 was not was not likely to jeopardize the continued existence of any ESA-listed species under NMFS jurisdiction. To date, approximately 454 individuals have been captured and 3 mortalities have been recorded. This study will continue through at least 2012.

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

NMFS is also a sub-permittee under USFWS' ESA Section 10 endangered species blanket permit. Research authorized under this permit is currently ongoing regarding Atlantic salmon in

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the Penobscot River to document changes to fish populations resulting from removal of the Veazie and Great Works Projects and constructing 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. 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. The hatcheries provide a significant buffer from extinction for the species.

4.4. Non-Federal Regulated Fishery Operations

Unauthorized take of shortnose sturgeon and Atlantic salmon is prohibited by the ESA. However, shortnose sturgeon are taken incidentally in anadromous fisheries along the East Coast and may be targeted by poachers (NMFS 1998). The Penobscot River is an important corridor for migratory movements of various species including alewife (*Alosa pseudohernegus*), American eel (*Anguilla rostrata*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), striped bass (*Morone saxatilis*) and lobster (*Homarus americanus*). It has been estimated that approximately 20 shortnose sturgeon are killed each year in the commercial shad fishery operating in the Northeast and an additional number are also likely taken in recreational fisheries (T. Savoy pers. comm. in NMFS 1998). However, the incidental take of shortnose sturgeon in the Penobscot River has not been documented due to confusion over distinguishing between Atlantic sturgeon and shortnose sturgeon and likely apprehension to report illegal bycatch to authorities. Due to a lack of reporting, no information on the number of listed shortnose sturgeon or Atlantic salmon caught and released or killed in commercial or recreational fisheries on the Penobscot River is available.

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.

4.5. Formal or Early Section 7 Consultations

In the Environmental Baseline section of an Opinion, NMFS discusses 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 March 17, 2008, NMFS issued an Opinion to USGS on the effects of sea run brook trout research in Cove Brook, a tributary to the lower Penobscot River. In the Opinion, NMFS

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concluded that the proposed action may adversely affect but was not likely to jeopardize the continued existence of listed Atlantic salmon. The ITS accompanying the Opinion exempted the incidental take of up to 22 Atlantic salmon annually. No shortnose sturgeon occur in the action area for this consultation, therefore no effects to shortnose sturgeon were anticipated.

On July 7, 2008, NMFS issued an Opinion to the ACOE New England District on the effects of removing the Brewer Dam on the Sedgeunkedunk Stream in Brewer, Maine. Sedgeunkedunk Stream is a small tributary to the lower Penobscot River. In the Opinion, NMFS concluded that the proposed action was not likely to jeopardize the continued existence of listed Atlantic salmon or shortnose sturgeon. The ITS accompanying the Opinion exempted the incidental take of up to two Atlantic salmon in the action area. No shortnose sturgeon occur in the action area for this consultation; therefore, no effects to shortnose sturgeon were anticipated.

4.6. Global Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities - frequently referred to in layman's terms as "global warming." Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The EPA's climate change webpage provides basic background information on these and other measured or anticipated effects (see www. epa.gov/climatechange/index.html). Activities in the action area that may have contributed to global warming include the combustion of fossil fuels by vessels.

The impact of climate change on Atlantic salmon is likely to be related to ocean acidification, changes in water temperatures, potential changes to salinity in rivers, and the potential decline of forage. These changes may effect the distribution of species and the fitness of individuals and populations due to the potential loss of foraging opportunities, displacement from ideal habitats and potential increase in susceptibility to disease (Elliot and Simmonds 2007). A decline in reproductive fitness as a result of global climate change could have profound effects on the abundance and distribution of Atlantic salmon in the action area, and throughout their range.

The impact of climate change on shortnose sturgeon in the action area is likely to be related to changes in water temperatures, potential changes to salinity in rivers, and the potential decline of forage species. These changes may affect the distribution of species and the fitness of individuals and populations due to the potential loss of foraging opportunities, displacement from ideal habitats and potential increase in susceptibility to disease (Elliot and Simmonds 2007). A decline in reproductive fitness as a result of global climate change could have profound effects on the abundance and distribution of shortnose sturgeon in the action area, and throughout their range.

As described above, global climate change is likely to negatively affect shortnose sturgeon and Atlantic salmon by affecting the distribution of prey, water temperature and water quality. Any activities occurring within and outside the action area that contribute to global climate change are also expected to negatively affect shortnose sturgeon and Atlantic salmon in the action area.

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4.7. Cumulative Threats from Other Activities

Cumulative impacts from federal and private actions occurring in the Penobscot have the potential to impact shortnose sturgeon and Atlantic salmon. These include direct and indirect modification of habitat due to hydroelectric facilities and the introduction of pollutants from paper mills, sewers, and other industrial sources. Hydroelectric facilities can alter the river's natural flow pattern and temperatures and release of silt and other fine river sediments during dam maintenance can be deposited in sensitive spawning habitat nearby. 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). Additionally, dams and culverts can block passage and prevent access to important habitats.

Cumulative impacts from federal and private actions occurring in the Penobscot River have the potential to impact Atlantic salmon and critical habitat designated for this species. These include direct and indirect modification of habitat due to hydroelectric facilities and the introduction of pollutants from paper mills, sewers, and other industrial sources. Hydroelectric facilities can alter the river's natural flow pattern and temperatures and release of silt and other fine river sediments during dam maintenance can be deposited in sensitive spawning habitat nearby. These facilities also often represent barriers to normal upstream and downstream movements. Passage through these facilities may result in the mortality of downstream migrants. 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).

4.8. Summary and Synthesis of the Status of the Species

The Status of the Species, Environmental Baseline, and Cumulative Effects Sections, taken together, establish a "baseline" against which the effects of the proposed action are analyzed to determine whether the action is likely to jeopardize the continued existence of the species or result in the destruction or adverse modification of designated critical habitat. To the extent available information allows, this "baseline" (which does not include the future effects of the proposed action) would be compared to the backdrop plus the effects of the proposed action. The difference in the two trajectories would be reviewed to determine whether the proposed action is likely to jeopardize the continued existence of the species. This section synthesizes the Status of the Species, the Environmental Baseline, and Cumulative Effects sections as best as possible given that some information on shortnose sturgeon is quantified, yet much remains qualitative or unknown.

Actions occurring in the action area have the potential to impact shortnose sturgeon and Atlantic salmon. Despite improvements in water quality and the elimination of directed fishing for these species, shortnose sturgeon and Atlantic salmon still face numerous threats in this river system. As noted above, the total effect of hydroelectric facilities in the Penobscot River Basin is largely unknown; however, it is certain that they affect habitat and connectivity in the Penobscot River for shortnose sturgeon and Atlantic salmon.

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4.8.1. Summary and Status of Atlantic Salmon

Adult returns for the GOM DPS remain well below conservation spawning escapement (CSE). For all GOM DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below CSE levels required to sustain themselves (Fay *et al.* 2006), which is further indication of their poor population status. The abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (approximately 10%) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS.

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

4.8.2. Summary and Status of Shortnose Sturgeon

Over 300 individual adult shortnose sturgeon have been documented in the Penobscot River since 2006 with preliminary population estimates ranging from 300 to 2000 adults. The particulars of population dynamics and habitat use of the Penobscot River population are currently being studied. Any estimate of population size is complicated by information regarding the interchange of individuals between the Kennebec River population, which is estimated to contain approximately 9500 adults. Without information on historical abundance, it is difficult to make determinations regarding the stability of the population or about the long term survival and recovery of this population. Due to uncertainties regarding population size and genetic diversity, it is difficult to predict how likely the population would rebound from catastrophic events (*e.g.*, oil or chemical spill, weather event etc.) that affect habitat quality, prey availability or result in direct mortality of a number of individuals. However, as there are likely several hundred adults in this population and the adults captured so far are likely several decades old, the available information indicates that this population is long lived and currently, relatively unexploited by fisheries. As such, NMFS believes that this population is likely stable but low when compared to historic population levels in the Penobscot River.

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 spawning populations are known to persist. 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 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting healthy populations are the St John, Hudson and

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possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

While no reliable estimate of the total size of the taxon exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in populations for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. Based on the best available information, NMFS believes that the abundance of shortnose sturgeon throughout their range is increasing with population growth continuing in the Hudson, Delaware and Kennebec. Some southern river populations are continuing to decline and other populations are stable, but at low levels. Overall, while the status of shortnose sturgeon throughout their range has improved since the time of listing, abundance and distribution are believed to be well below historic levels. Any conclusions on the status of individual populations or the species as a whole is complicated by a lack of information on juveniles in nearly all river systems, limited genetic information, and limited data on historical abundance.

5. EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects (direct and indirect) of the proposed action on 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 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 endangered shortnose sturgeon and the GOM DPS of Atlantic salmon. To accomplish these goals, the Trust proposes to decommission and remove the Veazie and Great Works Projects and decommission and build a nature-like fishway at the Howland Project. These activities will affect listed Atlantic salmon and shortnose sturgeon in the action area. In addition, the Trust intends to generate funds for project implementation by operating the hydroelectric facilities prior to dam decommissioning. It is presently unknown how long the Trust will need to operate the projects prior to raising sufficient funding for decommissioning. Sufficient funds have already been raise by the Trust for the removal of the Great Works Project. As such, any interim operation of the Great Works Project should be short (less than 1 year). For purposes of this BO, however, NMFS assumes that interim operations at the Veazie and Howland Projects will occur for no longer than 6 years prior to decommissioning. The sections that follow present NMFS analysis of the following: (1) interim operations prior to dam removal; (2) work associated with dam decommissioning; (3) operation of the Howland bypass; and (4) indirect effects to shortnose sturgeon following dam removal.

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5.1. Effects of Interim Operations

Hydroelectric dams are known to impact Atlantic salmon and shortnose sturgeon through habitat alteration, fish passage delays, entrainment in turbines and impingement on screens and/or racks. Currently, the Veazie, Great Works, and Howland Projects are operated pursuant to the terms and conditions of existing FERC licenses. After the Trust acquires title to the three dams, and prior to decommissioning and removal of the dams, the dams will be operated by the Trust in accordance with existing FERC license articles. Existing FERC license articles require the 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 reduce generation at the Veazie, Great Works, and Howland Projects for 2-weeks annually during the spring throughout the interim operating period.

5.1.1. Upstream Fish Passage

This section will analyze the effects to shortnose sturgeon and Atlantic salmon attempting to migrate upstream of the projects during the interim operation period. Upstream fishways currently exist at the Veazie, Great Works, and Howland Projects (see Section 2). These fishways will continue to be operated and maintained by the Trust until dam decommissioning activities commence. 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 sturgeon from accessing habitat upstream of the Veazie Dam.

Shortnose Sturgeon
As explained above, the Veazie Dam represents the first barrier to upstream migration to shortnose sturgeon. 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 shortnose sturgeon from accessing habitat upstream of the Veazie Dam. It is believed that prior to dam construction, shortnose sturgeon in the Penobscot River ranged to at least Milford (approximately rkm 70) and if they were able to pass the falls at Milford, as far as Mattaseunk (rkm 171). The Veazie and Great Works Dams have prevented shortnose sturgeon from accessing habitat upstream of rkm 47 and 54, respectively. Since historical data on shortnose sturgeon habitat use in the river is lacking, NMFS will assume that Penobscot River shortnose sturgeon 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 and Great Works facilities 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 sturgeon (i.e., Milford) the Howland Dam is

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not thought to represent a barrier to upstream passage for shortnose sturgeon.

No shortnose sturgeon have 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 shortnose sturgeon will occur in the interim operation period. This assumption is reasonable as shortnose sturgeon have only rarely been documented to attempt to use fishways (other than fish lifts). As little information is available on the habitat preferences of shortnose sturgeon in the river historically, it is difficult to assess the impacts of an additional 6 years of lack of access to habitats upstream of Veazie Dam. However, based on migration patterns of shortnose sturgeon in other river systems it is reasonable to expect that historically shortnose sturgeon would have accessed the additional 22 km of habitat between Veazie and Milford falls and that this habitat would have been used for overwintering, spawning, and as nursery grounds for juveniles. The interim operation of the Veazie project will continue to prevent shortnose sturgeon from accessing this historic habitat for an additional 6 years.

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 adequate and females are capable of reabsorbing eggs. This suggests that prespawners 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 location (rkm) 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 shortnose sturgeon. Habitat use of young-of-year (YOY) shortnose 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 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. 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

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Dam severely limits the amount of low salinity habitat that young shortnose sturgeon have access to. This likely limits the viability of early life stages of shortnose sturgeon and may contribute to high levels of mortality for larval and young of the year shortnose sturgeon.

The interim operation of the Veazie project over a 6 year period will continue to prevent shortnose sturgeon from accessing historic spawning, and potentially overwintering, habitats as well as limiting nursery habitat. Without an accurate estimate of the number of shortnose sturgeon in the Penobscot River, it is difficult to quantify the number of shortnose 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 6 year interim operation period, nearly all adult 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 shortnose sturgeon from the interim operation of the Veazie project include the effects of operations on flow and water quality downstream of the project. While the project is expected to continue to operate in run of river mode, project operations will continue to alter habitat conditions below the dam. Effects to shortnose sturgeon from dam operations are currently unknown; however, to the extent that interim operations alter water depth or velocity, interim operations could affect successful shortnose 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 operations affect normal spring flow conditions in the river, spawning of shortnose sturgeon in likely to be affected.

As shortnose sturgeon are not known to occur upstream of Veazie, the interim operations at Great Works will not affect upstream movements of shortnose sturgeon. Similarly, as shortnose sturgeon do not occur in waters immediately downstream of Howland, interim operations at Howland will not affect upstream movements of shortnose sturgeon.

Atlantic salmon

Atlantic salmon are known to successfully utilize upstream fishways at the Veazie, Great Works, and Howland Projects. However, none of the fishways are 100% effective at passing Atlantic salmon. At the Veazie Dam, passage success of radio tagged Atlantic salmon 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 1989a, Shepard and Hall 1991, Shepard 1995). In 2005, Holbrook (2007) documented passage success of 67% for adult Atlantic salmon at the Veazie Dam.

At Great Works Dam, passage success for Atlantic salmon ranged from 38% in 1990 to 95% in 1989, and averaged 81% over five years of study (Dube 1988, Shepard 1989a, Shepard and Hall 1991, Shepard 1995). Holbrook (2007) documented 50% (2005) and 12% (2006) passage success for adult Atlantic salmon at Great Works. In 2006, low passage success at Great Works was attributed to the lack of flashboards at the dam which makes the fishway inoperable.

Due to small sample sizes, varying release locations among study years, and other

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experimental design factors, cumulative upstream passage success at the Veazie and Great Works Dams is difficult to extract from these radio tag studies. However, in 1988 and 1989, respectively, 40% and 63% of study fish that were available below the Veazie Dam successfully passed both Veazie and Great Works Dams (Shepard 1995).

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.

Immediately following the transfer of title to the Trust, all three projects will be operating. As explained in the "Description of the Action" section above, sufficient funds have been raised for the removal of the Great Works Project so any period of interim operations of Great Works should be short (less than 1 year). As such, current levels of passage success will be experienced for one additional year.

In order to avoid exposure of Atlantic salmon to the effects of the work associated with the removal of Great Works, beginning in the year that Great Works is removed, Atlantic salmon will be trapped at Veazie and trucked to upstream locations. This procedure will also occur during the construction of the Howland bypass. The final phase of the project will be the removal of the Veazie Dam, which may not occur for six years. Thus for a six year period, upstream passage success will be dictated by success at negotiating the fish passage facility at Veazie.

Assuming that the Great Works Project is removed shortly after FERC orders decommissioning of the projects, any impacts to Atlantic salmon associated with the interim operational period are likely to be associated with only the Veazie and Howland Projects. While exact upstream fish passage efficiencies are not known at the Veazie and Howland Projects under all operational and environmental conditions, NMFS expects that each facility will be at least 75% effective at passing adult Atlantic salmon that are homing to areas in the Penobscot River above each

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facility. Adult salmon that are not passed at the Veazie and Howland Projects will either spawn in downstream areas, return to the ocean without completing reproduction, or die in the river. However, it is not possible to predict the fate of salmon that are unable to pass upstream of the dams.

5.1.2. Downstream Fish Passage

The Veazie, Great Works and Howland Projects all 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 decommissioning 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 (see Section 4), continuing to operate the Veazie, Great Works, and Howland Projects will affect downstream movements of Atlantic salmon in the Penobscot River watershed. Shortnose sturgeon will not 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.

It is presently unknown how long the Trust will need to operate the projects prior to raising sufficient funding for decommissioning. Sufficient funds have been raised for the removal of the Great Works Project so any period of interim operations at Great Works should be short (likely 2 years). Based on the best available information and for purposes of this Opinion, NMFS assumes that interim operations at the Veazie and Howland Projects will occur for no longer than 6 years prior to decommissioning.

Downstream migration of post-spawned Atlantic salmon adults (kelts) and smolts occurs primarily in April and May (see Section 4.1.1). Typically, high spring flows resulting from snow melt creates spillage over the spillways of the Veazie, Great Works, 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, 90% of the time at Great Works, 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).

Specific estimates of downstream passage efficiency and smolt survival under all potential operational and environmental conditions are not available at the Veazie, Great Works, and Howland Projects. 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 1991c). Assuming each dam contributed equally towards overall smolt mortality during the studies, mortality ranged from 13.0% to 23.1% at each facility. 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

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tagged smolts (n=291) were lost in the vicinity of the West Enfield, Howland, and Milford Dams. Flows in the Penobscot River were low in 2006 thus smolts likely passed each dam via turbine entrainment or downstream fishways. Thus in 2006, individual projects could have contributed up to 20% loss of smolts which would include losses via turbine entrainment, predation, and over spillways. Given these data, FERC's (1997) estimates of downstream mortality at Veazie (0.75%), Great Works (1.05%), and Howland (2.07%) appear unreasonable. NMFS considers the above data to be the most reliable and best available information for describing potential injury rates to salmon passing hydroelectric projects in the Penobscot River watershed.

The potential for delays in the timely passage of smolts encountering the Veazie, Great Works, 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, 1989). 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, Great Works, 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.

The Trust's proposal for shutdowns during its interim operations of the three projects will significantly add to the levels of protection afforded to smolts and kelts during their out-migration. As discussed above, NMFS assumes 75% of the population of Atlantic salmon migrating in the spring will pass each project during the 2-week turbine shut-down period. Assuming a worst-case downstream passage scenario of low flows in Penobscot River during the interim period, approximately 7.8% of flows will be diverted to the operation turbine at Veazie, 7.8% at Great Works, and 33.3% at Howland. According to Shepard (1991), the route of passage selected at a hydroelectric dam may be proportional to the comparative water flow.

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Under this scenario, 7.8% of downstream migrants at Veazie and Great Works could pass through the operating turbine; at Howland, 33.3% of downstream migrants could pass through the operating turbine. Therefore, at the Howland Project, NMFS assumes the following: a) 15% of the entire Penobscot River population originates in the Piscataquis River[8]; b) 75% of these fish would pass the Howland Project during the 2 week turbine shut-down period; c) 33.3% of these fish would be entrained at the single operating turbine. Under this assumption, 3.7% of the total run of Atlantic salmon emigrating in the Penobscot River would pass the turbine at the Howland Project (3.7% = 15% x 75% x 33.3%). At Great Works and Veazie, the entire salmon run in the Penobscot River watershed must pass each project. Therefore, at Great Works, NMFS assumes 5.8% of the run of Atlantic salmon would pass through the projects' operating turbine (5.8% = ((75% - fish lost at Howland) x 7.8%). At Veazie, NMFS assumes 5.7% of the run would pass the projects' operating turbine (5.7% = ((75%- fish lost at Howland and Great Works) x 7.8%). Based upon studies conducted in the Penobscot River, approximately 20% of Atlantic salmon passing the project turbines at Howland, Great Works, and Veazie could experience delay, injury or death at each dam (Table 4).

For the remaining 25% of the total salmon run that would pass when the projects turbines are all operational, NMFS anticipates that 20% of these fish would experience delay, injury, or death at each facility. Combining potential losses of salmon during the two week shutdown period with losses occurring the rest of the outmigration period, NMFS anticipates that not more than 13.6% of the entire salmon run in the Penobscot River watershed would experience delay, injury, and death annually during the 6-year interim operational period of the Veazie, Great Works, and Howland Dams. Recognizing that flows in the Penobscot River during the spring typically exceed the hydraulic capacity at each dam (see Attachment A) and sufficient funds have been raised for the removal of the Great Works Project, the actual percentage of smolts experiencing delay, injury, or death during the interim period is likely to be significantly less than 13.6%. Although some adults may chose to outmigrate soon after spawning during a period when all turbines could be operating at the projects, NMFS does not expect more than 13.6% to be affected annually during interim operations as Great Works is not likely to operate for multiple years. It is not possible to estimate the actual number of smolts and kelts that would be affected by interim operations as population estimates are not presently available.

The worst-case scenario of 13.6% losses of Atlantic salmon is expected to occur for only 2 years. Once Great Works Dam is removed, the percentage of Atlantic salmon delayed, injured, or killed at Veazie and Howland during years 3-6 will fall to 7.5%. Following removal of Veazie, the percentage of Atlantic salmon harmed at Howland Dam will be approximately 1.5%.

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Table 4. Percentage of Penobscot River Atlantic salmon population potentially affected by turbine entrainment at the Howland, Great Works, and Howland Dams during the interim operation period.

Project	% population entrained during 2-week turbine shutdown period	% population delayed, injured, or killed during 2- week shutdown	% population delayed, injured, or killed during remaining migration period (no turbine shutdowns)	Total % population delayed, injured, or killed annually	Estimated number of years of interim operation
Howland	3.7[8]	0.7	0.8	1.5	6
Great Works	5.8	1.2	4.9	6.1	2
Veazie	5.7	1.1	4.9	6.0	6
			Total	13.6	

5.1.3. Critical Habitat

As discussed in Section 3.1.3, critical habitat for Atlantic salmon has been designated in the Penobscot River including the sections of river in the vicinity of the Veazie, Great Works, 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. NMFS expects 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, NMFS expects 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, NMFS expects these effects to be temporary, ceasing upon decommissioning of the projects. Table 5, which summarizes the effects of the interim operations on critical habitat for the environmental baseline, would also represent impacts on critical habitat during interim operations at the Veazie, Great Works, and Howland Projects.

5.2. Effects of Veazie and Great Works 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). Since dam removal activities at each project are likely to occur during summer/fall low flow periods, the only lifestages of Atlantic salmon potentially affected by construction activities would be parr and adults. Shortnose sturgeon juvenile and adults

8 Assumes Piscataquis River contributes 15% of annual run based upon current stocking distribution in Penobscot River

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occurring below the Veazie Dam could also be affected by dam removals. The effects of the removal process on listed Atlantic salmon and shortnose sturgeon are described below.

Effects of Removal of Veazie Dam

Effects of 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 area between the former Bangor dam and the Veazie Dam is 1.03 sq. km. The best available information on the presence of shortnose sturgeon in the area where effects of dam removal activities will be experienced is presented below.

If spawning is occurring in the Penobscot River, early life stages of shortnose sturgeon are expected to be present downstream of the Veazie Dam. As exact spawning locations have not been identified it is difficult to predict where exactly eggs and larvae would be present. Shortnose sturgeon eggs generally hatch after approximately 9-12 days (Buckley and Kynard 1981). The larvae are photonegative, remaining on the bottom for several days. Larvae are expected to begin swimming downstream at 9-14 days old (Richmond and Kynard 1995). Larvae are expected to be less than 20mm TL at this time (Richmond and Kynard 1995). This initial downstream migration generally lasts two to three days (Richmond and Kynard 1995). Studies (Kynard and Horgan 2002) suggest that larvae move approximately 7.5km/day during this initial 2 to 3 day migration. Eggs and larvae are likely concentrated near the spawning area for up to 4 weeks post-spawning, after which larvae disperse into downstream into the tidal river. Based on water temperature data, shortnose sturgeon spawning is likely to occur during the month of May in the Penobscot River. As such, larvae are likely to have dispersed into the river by the end of June. As in water work will not begin until July 1, no shortnose sturgeon eggs or larvae are likely to be present in the area where effects of in-water work associated with dam removal activities will be experienced.

Based upon radio telemetry data collected by UM in 2006 and 2007 (Figure 2), between 1 and 10 tagged shortnose sturgeon were present in the area above the Bangor dam on a given sample date between early June and late October. Most shortnose sturgeon were documented above the former Bangor Dam during late summer and fall months. During this time up to 2 of 7 (28%) acoustically tagged fish were present in this river reach in 2006 and up to 10 of 12 (83%) acoustically tagged fish present in this river reach in 2007 (Figure 2). Based upon this information, it is likely that a significant portion of the adult shortnose sturgeon in the Penobscot River are likely to be exposed to effects of the in-water work associated with dam removal activities.

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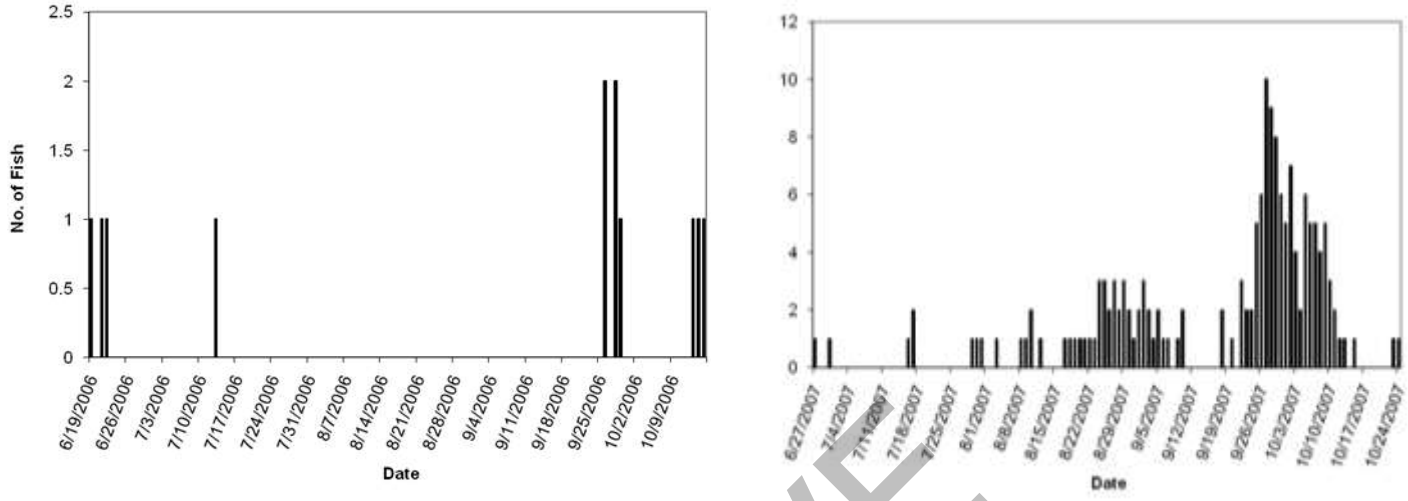

Figure 2. Date and number of shortnose sturgeon detected above the Bangor Dam in 2006 and 2007.

According to University of Maine data from 2006 and 2007, most shortnose sturgeon detected above the Bangor during the period of August to mid September were detected at depths greater than 2.5m. During this time period in 2006, the mean depth on all detection dates was ≥2.5m (6 out of 6), in 2007 the mean detection depth was ≥2.5m on 35 days (out of 46; 76%). By mid-October, all adult shortnose sturgeon are likely to have moved downstream to the overwintering area.

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 occur in the 4 km stretch of the Penobscot River from the Veazie Dam downstream to the Town of Hampden and that a portion of the juveniles would similarly be present in the area upstream of the old Bangor dam. The location of overwintering juvenile shortnose sturgeon is not known; however, based on migration patterns of shortnose sturgeon in other river systems, shortnose sturgeon juveniles are likely to overwinter just upstream of the saltwater-freshwater interface.

Based on the best available information outlined above, shortnose sturgeon adults and juveniles are likely to be present near Veazie Dam between July 1 and mid-October and therefore, could be exposed to effects of dam removal operations during this time period.

Based on the current schedule, dam removal activities at Veazie will not commence until after the Great Works Dam is removed and sufficient funds have been raised to support the removal of the Veazie Dam. 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

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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 shortnose sturgeon and Atlantic salmon as well as effects to Atlantic salmon critical habitat are detailed below.

5.2.1. Water Quality

Sediments and Turbidity

Removal of the Veazie and Great Works Dams and associated features would require the use of extensive heavy equipment in the Penobscot River. Construction activities associated with dam removal activities including spillway removal, powerhouse removal, 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 sediments accumulated in the impoundments of each project are 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 (20,000 to 58,000 cubic yards), with most of it located along the western shoreline and removed from the location of the dam. At Great Works, cobble, boulder, and bedrock comprise 97% of substrates with only 1,300 to 10,000 cubic yards of accumulated fine materials in the impoundment. 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 TSS concentrations have the potential to adversely affect adult and juvenile Atlantic salmon 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,

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leading to depressed DO concentrations, and can physically trap emerging fry on the gravel.

Shortnose sturgeon are generally more tolerant of elevated TSS levels than salmonids. While there have been no directed studies on the effects of TSS on shortnose sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water and Dadswell *et al. (*1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. The life stages of shortnose sturgeon most vulnerable to increased sediment are eggs and larvae which are subject to burial and suffocation. As explained above, due to in-water work only occurring after July 1, no shortnose sturgeon eggs or larvae are likely to be present in the area where effects of in-water work associated with dam removal activities will be experienced.

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 6 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 redeposited sediments also have the potential to adversely affect primary and secondary productivity (Spence et al. 1996), and to reduce incubation success (Bell 1991) and cover for juvenile salmonids (Bjornn and Reiser 1991). Larger juvenile and adult salmon appear to be little affected by

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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. Deposition of sediments could also affect shortnose sturgeon spawning and rearing habitat below the Veazie Dam.

State fishery agencies recently estimated juvenile Atlantic salmon production in the Penobscot watershed, using habitat surveys and suitability modeling. (MDMR, 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, MDIFW 2009).

While there have been no directed studies on the effects of TSS on shortnose sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water, and Dadswell *et al.* (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, shortnose 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 shortnose 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 shortnose 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 shortnose sturgeon between foraging areas and/or concentration areas during dam removal or otherwise negatively affect shortnose sturgeon in the action area. As shortnose sturgeon do not occur in the vicinity of Great Works, effects from turbidity and suspended sediment are limited to the area below Veazie.

Given that accumulated sediments are limited in the Veazie and Great Works impoundment and BMPs for erosion and sedimentation control will be employed throughout construction activities and no parr are expected to occur downstream of the Veazie and Great Works Projects, NMFS does 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. For Atlantic salmon, it is unlikely that any significant number of parr would be present below each project during construction activities since neither

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area is 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.

Contaminants

Use of heavy equipment 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 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 Atlantic salmon or shortnose sturgeon as a result of contaminants from heavy equipment in the action area would be discountable.

Sediment cores taken from the Veazie and Great Works Projects 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 (Nelson et al. 1991).

It is difficult to predict the concentrations of contaminants that would be mobilized into the water

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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 (1-4 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 (4 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 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 shortnose sturgeon and Atlantic salmon. As such, the resuspension 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 and shortnose sturgeon.

5.2.2. Fish Passage

Activities associated with the removal of the Veazie and Great Works Projects have the potential to affect upstream and downstream migrations of Atlantic salmon and shortnose sturgeon in the lower Penobscot River. However, as dam removal activities will commence in July during low flow conditions in the Penobscot River and the turbines will be removed along with most of the remainder of the projects works prior to the downstream migration period the following spring, no Atlantic salmon smolts are expected to be affected by these activities. As explained above, shortnose sturgeon do not use the fish passage facilities at Veazie. If shortnose sturgeon 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 shortnose sturgeon spawning will be completed at the time of dam removal activities, movements of spawning adults are thus not expected to be affected. Therefore, only passage of upstream migrating Atlantic salmon adults could be affected by dam removal activities.

The Trust plans to remove the Great Works Dam first. Veazie Dam, along with its operating fishway and trap would remain in place until Great Works Dam is removed. Upstream migrating Atlantic salmon will be collected at Veazie fishway and trucked around Great Works Dam by the MDMR[9]. The fishway and trap at Veazie would continue to be used to collect broodstock salmon during the removal of Great Works Dam. Therefore, removal of the Great Works Project is not expected to affect upstream migrating Atlantic salmon.

Removal of the Veazie Dam will commence July 1 to allow the majority of the upstream migration of salmon to occur prior to work activities. Since most adult salmon enter the

9 The MDMR holds a Section 10(a)(1)(A) research permit under the US Fish and Wildlife Services' regional endangered species blanket permit (No. 697823) which authorizes the handling of listed Atlantic salmon

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Penobscot between May and mid-July (Fay et al. 2006), only a small portion of the overall run could be delayed by removal work at Veazie. Trap counts obtained at the Veazie Dam during 2007-2009 suggest that about 80% 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 3-4 week period, the Veazie fishway will be inoperable. Therefore, NMFS expects that up to 20% of the run of adult salmon in the Penobscot River could be delayed 3-4 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, NMFS anticipates that some of these fish will resume their upstream migration once passage is restored or chose to spawn in downstream tributaries such as Kenduskeag Stream, Duck Trap River, or Cove Brook. Nevertheless, a 3-4 week delay in upstream migration would 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, NMFS cannot predict whether impacts will actually occur to adult salmon.

Hydraulic modeling at the Great Works Project has indicated that there may be two locations at the site where post-removal velocities and depths may impede upstream movements of adult salmon following removal. The hydraulic modeling indicated that zone of passage problems would occur only at low flow conditions during the summer months, not earlier in the year when salmon are typically migrating upstream. NMFS anticipates a suitable zone of passage for salmon following removal of Great Works will be available to allow successful migration past the former dam site. Similarly, shortnose sturgeon are not expected to be impeded from moving upstream past the site of Great Works following dam removal.

Decommissioning and removing the Great Works project may result in relocation of the 40” diameter water supply intake for the existing Red Shield Mill. The existing pipe draws water from the Great Works impoundment. While the Trust will not be responsible for installing the new water intake structure, replacing the existing water pipe must be considered an interrelated activity to the overall action under consideration with the FERC. Replacing the pipe will likely require some instream work in the Penobscot River. The mill is currently permitted to withdraw up to 28 million gallons per day. This small reduction in flows in the Penobscot River is not expected to create any passage problems for Atlantic salmon. If, however, the pipe is not properly screened, some entrainment and impingement of Atlantic salmon will occur. As Red

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Shield will require a permit from the ACOE to replace the pipe, NMFS expects a separate Section 7 consultation will be needed to assess any impacts associated with the operation of the intake pipe on Atlantic salmon and shortnose sturgeon populations in the Penobscot River.

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, shortnose 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 impairments to shortnose sturgeon passage.

Other Effects of Dam Removal Activities
Noise will also be generated by equipment operating on the access roads. However, there is expected to be minimal transmission of this noise to the underwater area where shortnose sturgeon and Atlantic salmon will be present as sound from one environment (air or water) is not easily transmitted across the air-water interface (Akamatsu, et. al. 2002, as referenced in Popper 2003). As such, any increase in underwater noise associated with dam removal activities.

5.2.3. Atlantic Salmon Critical Habitat

Removal of the Veazie and Great Works Dams will temporarily reduce the status of several habitat indicators relative to Atlantic salmon critical habitat. NMFS expects the dam removals to cause temporary adverse effects to some primary constituent elements of critical habitat, including water quality, substrate, and safe passage. However, these adverse effects would be short-term in nature and cease when dam removal is complete. Upon completion of dam removal, overall habitat conditions in the action area would greatly improve as discussed below.

5.2.4. Effects After Dam Removal

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

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 and Great Works Dams. 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 Veazie fishway trap. Atlantic salmon smolts would no longer experience delays or injury and death due to ineffective downstream fishways at both dams.

Designated critical habitat in the project areas will also improve for Atlantic salmon following dam removal at Veazie and Great Works. Removal of the Veazie and Great Works Dams will restore over 5.4 miles of free-flowing riverine habitat in the Penobscot River. Based on

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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 both dams 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 5 below summarizes the condition of essential features of Atlantic salmon critical habitat following removal of the Veazie and Great Works Dams.

Table 5. Atlantic salmon critical habitat essential features following removal of the Veazie and Great Works Dams.

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 impoundments will restore spawning and rearing habitat, decrease predation, increase productivity, and facilitate migrations.	Adult abundance and productivity Juvenile growth rate
Water Quality	Adult, juvenile, incubating eggs	Freshwater spawning and rearing	Removing impoundments will improve water quality (temperature and dissolved oxygen) for spawning and rearing habitat.	Adult abundance and productivity Juvenile growth rate

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Shortnose sturgeon

The removal of the Veazie and Great Works Dams will allow shortnose sturgeon to access habitat upstream of these projects. As explained above, shortnose sturgeon are thought to have historically ranged as far upstream as Milford Falls (rkm 70). The removal of the Veazie and Great Works Dams will allow shortnose sturgeon to access 22 km of river 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. Due to likely improved spawning success and improved viability of early life stages and juveniles, it is reasonable to expect that the removal of the Great Works and Veazie Dams will result in an increase in the abundance and distribution of shortnose sturgeon in the Penobscot River. The

removal of these dams is also likely to result in an increase in the theoretical carrying capacity of this population as there will be more accessible habitat.

With the removal of the Veazie and Great Works Dams, it is likely that the range of shortnose sturgeon in the mainstem Penobscot River will extend to the base of the Milford Dam and in the Stillwater Branch will extend to the base of the Orono Dam. The operations of these dams could effect shortnose sturgeon occurring downstream of these facilities. As such, potential effects of the operations of these projects on shortnose sturgeon are discussed below.

The Milford and Orono projects operate under licenses issued by FERC. Both dams have upstream passage facilities consisting of pool and weir type design. This type of facility is not known to be used by sturgeon, and it is unlikely that any sturgeon would attempt to pass upstream of the Milford Dam via this facility. As such, it is extremely unlikely that any shortnose sturgeon would experience injuries resulting from operation of this fishway. Operation of both projects is run of river which will minimize the likelihood of pulsed discharges which could result in stranding of adults or early life stages or the scouring of habitats. Without information on the specific habitats (i.e., depth, velocity, and substrate type) present immediately downstream of the Milford and Orono projects, it is difficult to predict how close to the dam sturgeon are likely to be present and therefore, difficult to predict what effects operations of the dam are likely to have on shortnose sturgeon. However, it is likely that if suitable habitat is present, shortnose sturgeon would spawn near the dam. Based on currently available information, velocities are likely too high in the tailrace for this area to support spawning and spawning would be more likely to occur near the spillway or further downstream away from the high velocities in the tailrace. There is currently not enough information on the future operations of the Milford or Orono projects to predict what effects operations will have on shortnose sturgeon; however, potential effects are likely to be attributable to changes in habitat conditions below the dam as a result of project operations. These could include stranding of shortnose sturgeon in pools during flashboard replacement or the alteration of conditions below the dam that could affect spawning adults or the viability of early life stages.

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5.3. Effects of Howland Dam Surrender and Bypass Construction

The primary effects associated with the decommissioning the Howland Project will be construction of the fish bypass and lowering the impoundment 3.8 feet. All lifestages of Atlantic salmon could be affected by these activities. As shortnose sturgeon do not occur in the project area, no effects to shortnose sturgeon are expected. The direct and indirect effects of constructing the bypass and lowering the impoundment on listed Atlantic salmon are described below.

5.3.1. Water Quality

<u>Sediments and Turbidity</u>

Little instream 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. Instream 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, NMFS expects any increases in either turbidity or sediments to be temporary and short-lived. Section 5.2.1 discussed the effects of sediments and turbidity on Atlantic salmon and other salmonids. Given the limited and temporary nature of any sediments and turbidity, NMFS does not expect any Atlantic salmon mortalities from construction of the fish bypass. Rather, any salmon present in the area are likely to experience behavioral avoidance of 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 polyaromatic hydrocarbon 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.

5.3.2. Fish Passage

Decommissioning of the Howland Project along with construction of the fish bypass and improvements to downstream passage will benefit Atlantic salmon passage in the Piscataquis. 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 provide safe, timely, and effective passage of diadromous fish including Atlantic salmon. NMFS anticipates 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 decommissioning, Atlantic salmon adults and smolts would no longer experience turbine

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entrainment or impingement. Adult Atlantic salmon returning to spawn in the Piscataquis River are not expected to experience delays in migration. Atlantic salmon smolts would no longer experience delays or injury and death due to ineffective downstream fishways at the Howland Dam. 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.

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.

5.3.3. 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. NMFS expects 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 the bypass is completed. Upon completion of the bypass and lowering the impoundment, overall habitat conditions in the action area would improve as discussed below.

Designated critical habitat in the project areas will improve for Atlantic salmon following lowering the project impoundment 3.8 feet. 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 dam could also improve water quality and reduce vulnerability to losses of salmon to predation. Table 6 below 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.

Table 6. Atlantic salmon critical habitat essential features following construction of fish bypass and lowering the impoundment at the Howland Project.

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.

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Habitat Elements, Channel Dynamics, Watershed Condition	Adult, incubating eggs, juvenile, smolt	Freshwater migration, spawning, and rearing	Lowering impoundment will restore spawning and rearing habitat, decrease predation, increase productivity, and facilitate migrations.	Adult abundance and productivity Juvenile growth rate
Water Quality	Adult, juvenile, incubating eggs	Freshwater spawning and rearing	Lowering impoundment will improve water quality (temperature and dissolved oxygen) for spawning and rearing habitat.	Adult abundance and productivity Juvenile growth rate

5.4. 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 drawdowns 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; and 4) placement of stone riprap at the base of existing walls as a splash pad. The exact scope and extent of these infrastructure modifications cannot be determined until dam removal has been completed and each site is surveyed. However, the ACOE anticipates that work will be localized and small in nature. Approximately 24 cubic yards of fill covering 4,500 square feet of river bottom will likely be needed for erosion control at the Veazie site. At Great Works, approximately 99 cubic yards of fill covering 16,620 square feet will be needed for erosion control. Approximately 175 cubic yards of fill will be needed to extend the Eddington boat launch and for reinforcement of storm drains, culverts, etc. The Corps has proposed a permit condition such that these activities occur between July 1 and April 9th. 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 shortnose sturgeon or adult Atlantic salmon in the action area. Therefore, effects of these activities will be insignificant and discountable.

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6. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR §402.02 as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation. The following section discusses potential cumulative effects that are reasonably certain to occur to shortnose sturgeon and Atlantic salmon with the action area of this consultation.

The effects of future state and private activities in the action area that are reasonably certain to occur during construction activities associated with the decommissioning of the Veazie, Great Works, and Howland Projects are continuation of recreational fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation. Research activities on shortnose sturgeon by UM are also likely to continue during the proposed project. UM has been granted a Scientific Research Permit (Permit No. 1595) by NMFS to capture 200 shortnose sturgeon annually in the Penobscot River for a five year period (2007-2011), with no more than two mortalities annually. Permit 1595 does not authorize any lethal take of listed Atlantic salmon in the Penobscot River during research activities.

Impacts to shortnose sturgeon and Atlantic salmon from non-federal activities are largely unknown in the Penobscot River. It is possible that occasional recreational fishing for anadromous fish species may result in incidental takes of shortnose sturgeon and Atlantic salmon. 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 shortnose 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.

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.

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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 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.

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

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7. INTERGRATION AND SYNTHESIS OF EFFECTS

7.1. 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 (approximately 10%) 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.

NMFS finds that removal of the Veazie and Great Works Projects 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, NFMS also finds 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. Interim 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.

Additionally, the dam removal process and construction of the Howland fish bypass would cause short-term impacts to Atlantic salmon in the form of increased suspended sediments concentrations in the action area and delays in fish passage. NMFS determines 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 (6 years). Additionally, the proposed action includes numerous measures which should reduce the adverse impacts of interim operations and instream work on listed species and critical habitat. Once the fish bypass is completed and the turbines are removed, NMFS does not anticipate any continued delay, injury, or death of salmon at the project.

Finally, after removal of the Veazie and Great Works Dams and surrender of the Howland Project license, NMFS expects that the condition of many habitat features in the action area will greatly improve. Removal of the dams would restore passage conditions, eliminate turbine entrainment and impingement, improve water quality, improve rearing and spawning habitat, and improve prey resources in the river.

NMFS believes that the authorization of the proposed action would temporarily reduce the reproduction and distribution of Atlantic salmon in the Penobscot River. However, the short-term natures of these effects is not expected to have lasting effects of the GOM DPS of Atlantic salmon. After the dams are removed and passage and habitat is restored in the action area, NMFS anticipates a net benefit to the population of Atlantic salmon in the Penobscot River watershed. While the loss of juvenile and adult salmon during the duration of the proposed action (6 years) will have an effect on the number of Atlantic salmon in the Penobscot River, it is not likely that this effect will not be detectable at a population level shortly after the project is completed; therefore, the take of Atlantic salmon will not have an appreciable effect on the species as a whole. For these reasons, NMFS believes that there is not likely to be any long-term reduction in reproduction and distribution and ultimately an increase in the abundance and distribution of Atlantic salmon in the Penobscot River. As such, there is not likely to be an appreciable long-term reduction in the likelihood of survival and recovery in the wild of the Penobscot River population or the species as a whole.

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7.2. Shortnose Sturgeon

Shortnose sturgeon are endangered throughout their entire range. This species exists as nineteen separate populations that show limited evidence of interbreeding. The shortnose sturgeon residing in the Penobscot River form one of these nineteen populations.

Interim operations of the Howland and Great Works projects are not likely to result in negative effects to shortnose sturgeon because the Howland project is located upstream of the historic upstream limit of shortnose sturgeon in the Penobscot River and because the Veazie Dam precludes access to the waters below the Great Works project. The interim operation of the Veazie project for no more than six years 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. The continued operation of the Veazie project over the interim period is also likely to continue to 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 result in the mortality of any adult shortnose sturgeon although it may contribute to the mortality of early life stages, including juveniles, due to its limiting access to freshwater rearing habitat.

The removal of the Veazie and Great Works Dams will restore access to approximately 22 km of habitat for shortnose sturgeon. This is likely to improve spawning and rearing success and may provide additional foraging and overwintering opportunities. The restoration of access to the likely 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 adult and juvenile 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). Based on the best available information, shortnose sturgeon are likely to be present near the Veazie Dam between July 1 and early October, as such, during that time period any shortnose sturgeon present near the dam 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 shortnose 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 shortnose sturgeon adults and juveniles 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.

As explained above, while the interim operations of the Veazie Dam are not expected to result in the direct mortality of any shortnose sturgeon, the interim operation is likely to reduce the number of shortnose sturgeon in the Penobscot River by precluding access to upstream spawning grounds and by limiting the availability of low salinity rearing habitat for early life stages and juveniles. As a result, the abundance of shortnose sturgeon in the Penobscot River is likely to continue to be depressed for the additional 6 years that Veazie Dam will operate. However, as the proposed action includes the removal of the Veazie and Great Works Dams, which will result in the restoration of access to 22km of upstream habitat which has been blocked for over 100 years, the action is ultimately expected to result in an increase in the abundance and distribution of shortnose sturgeon in the Penobscot River, and therefore an increase in the numbers of

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shortnose sturgeon throughout their range as compared to the number that would have been present absent the proposed action. This increase in numbers is expected to result from increased availability of spawning habitat and increased availability of low salinity habitat which will likely result in the improved viability of early life stages and juveniles.

Similarly, while the interim operations of the Veazie project will result in the reduction of reproduction of shortnose sturgeon in the interim period by continuing to block access to historic spawning grounds, the ultimate removal of the Veazie Dam and the Great Works Dam is expected to result in an increase in reproduction due to access to upstream spawning habitats. Therefore, there is expected to be an increase in reproduction following dam removal as compared to the amount of reproduction that would have occurred absent the proposed action.

The proposed action will continue to reduce the distribution of shortnose sturgeon in the Penobscot River during the interim operation period. However, following dam removal, the full historic range of shortnose sturgeon in the mainstem Penobscot River will be restored. Therefore, the ultimate effect of the proposed action will be an increase in distribution of shortnose sturgeon in the Penobscot River compared to the distribution of shortnose sturgeon in the river absent the proposed action. The proposed action will not affect the distribution of shortnose sturgeon outside the Penobscot River and will neither increase or decrease distribution throughout the species range.

Based on the information provided above, while the interim operations of the Veazie project will continue to reduce the numbers, reproduction and distribution of shortnose sturgeon over the 6 year interim operation period, the proposed action will ultimately result in an increase in numbers, reproduction and distribution of shortnose sturgeon. The interim operations over the 6 year period prior to dam removal will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for this species given that: (1) the population trend of shortnose sturgeon in the Penobscot River is stable; (2) the interim operations will not be different from the baseline conditions which are supporting at least an estimated 1,000 adult shortnose sturgeon in the Penobscot River; (3) pre-spawning shortnose sturgeon in the Penobscot River have been demonstrated to move to the Kennebec River where they are presumably successfully spawning; (4) interim operations will occur for only 6 years, which represents only 2-3 reproductive cycles of an individual shortnose sturgeon and represents a small percentage of the total life span of an individual fish; (5) the continued reduced numbers and reproduction of shortnose sturgeon in the Penobscot for an additional 6 year period will not change the status or trends of the species as a whole; (6) the action will have no effect on the rangewide distribution of shortnose sturgeon; and (7), the proposed action will ultimately result in an increase in numbers, reproduction and distribution of shortnose sturgeon in the Penobscot River, and therefore in the species as a whole.

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 factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range, (B) overutilization for commercial, recreational, scientific, or educational purposes, (C) disease or predation, (D) the

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inadequacy of existing regulatory mechanisms, (E) other natural or manmade factors affecting its continued existence. Recovery of a species occurs when listing it as an endangered or threatened species is no longer warranted. As explained above, the proposed action will not appreciably reduce the likelihood of survival of shortnose sturgeon. Also, it is not expected to modify, curtail or destroy the range of the species since it will result in an increase in the number of shortnose sturgeon in the Penobscot River and since it will not affect the overall distribution of shortnose sturgeon other than to result in an increase in distribution in the Penobscot River. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect any of these species of shortnose sturgeon, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will result in an increase in numbers and reproduction in the Penobscot River which will result in the improvement of overall reproductive fitness for the species as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

8. CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon or Atlantic salmon. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of Atlantic salmon critical habitat.

9. INCIDENTAL TAKE STATEMENT

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. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as spawning, rearing, feeding, and migrating (50 CFR §222.102; NMFS 1999b). The term "harass" has not been defined by NMFS; however, it is commonly understood to mean to annoy or bother. In addition, legislative history helps elucidate Congress' intent: "[take] includes harassment, whether intentional or not. This would allow, for example, the Secretary to regulate or prohibit the activities of birdwatchers where the effect of those activities might disturb the birds and make it difficult for them to hatch or raise their young" (HR Rep. 93-412, 1973). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity by a Federal agency or applicant (50 CFR §402.02). 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 the incidental take statement.

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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 FERC and/or ACOE fails to include these conditions in the decommissioning order or Section 10 permits respectively, 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 FERC 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)).

9.1. Amount or Extent of Take

The FERC's proposed action is designed to minimize the short-term incidental take of Atlantic salmon and to permanently improve and restore access to Atlantic salmon and shortnose sturgeon spawning and rearing habitat above the existing dam sites. In Section 5, NMFS described the mechanisms by which ESA-listed anadromous fish and designated critical habitat would likely be affected by interim operations and removal or decommissioning of the Veazie, Great Works, and Howland Dams. The following sections describe the amount or extent of take that NMFS expects 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 FERC would need to reinitiate consultation. The exempted take includes only take incidental to the proposed action.

9.1.1. Pre-Removal Activities

Atlantic salmon
NMFS anticipates that continued operation of the Great Works Project for 2-years and operation of the Veazie and Great Works Projects for 6-years could potentially kill or harm Atlantic salmon adults and smolts in the Penobscot and Piscataquis Rivers. The Trust's proposal to reduce generation during the smolt and kelt migration period, however, will significantly reduce the number of takes associated with the project. Based upon the protective measures proposed by the Trust, NMFS anticipates that not more than 5.8% of the Penobscot River population of Atlantic salmon would be delayed[10], injured, or killed during interim operations of the Great Works Project for 2-years. At Veazie and Howland, NMFS anticipates that not more than 6% and 1.5%, respectively, of the Penobscot River population of Atlantic salmon would be delayed, injured, or killed during the 6-year interim operation period. Regarding upstream passage during interim operations, NMFS expects that each facility will be at least 75% effective at passing upstream migrating adults; therefore, no more than 25% of the entire run of adults would be delayed during the period of interim operations. This level of take is expected to occur for no more than 6 years following issuance of FERC's decommissioning orders and ACOE permits.

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

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NMFS believes this level of incidental take is reasonable given the seasonal distribution and abundance of Atlantic salmon in the action area. In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the either species. It is not possible to monitor the exact numbers of takes of Atlantic salmon or shortnose sturgeon. For Atlantic salmon, NMFS 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, Great Works, or Howland Dams occurred significantly earlier or later (i.e., more than 7 days) than river temperatures reaching 10°C, the Trust must consult with NMFS to determine whether the timing of shutdowns should be modified. Each year, NMFS will review water temperature data and the dates of turbine shutdowns to determine whether incidental take levels for Atlantic salmon were exceeded.

Amount or Extent of Incidental Take of Shortnose sturgeon

The proposed action has the potential to affect shortnose 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 shortnose sturgeon in the Penobscot River is thought to have extended to Milford Falls (rkm 70). The Veazie Dam and Great Works Dam preclude access to approximately 22km of habitat. While these dams will be removed as part of the proposed action, interim operations will continue to preclude access for a six year period. 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 6 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 operations of the Veazie and Great Works projects will be considered harm because the operations of these projects preclude access to upstream habitats necessary for successful spawning which not only disturbs individual shortnose sturgeon by precluding them from accessing upstream habitats and interrupts normal behaviors (i.e., migrating upstream of the existing projects) but also by impairing their ability to carry out these normal functions by reducing the reproductive fitness of individual shortnose sturgeon by reducing the available habitat for spawning and by reducing the viability of any offspring. Adult shortnose sturgeon spawn every 2-3 years. Thus, over the 6 year interim operation period, all adult shortnose sturgeon in the Penobscot River would normally spawn. Therefore, the proposed action is likely to result in the harm of all adult shortnose sturgeon attempting to spawn in the Penobscot River over the six year interim operation period. Similarly, the proposed action will result in the harm of all larvae and juveniles produced in the six year interim operation period 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 shortnose sturgeon.

Despite the use of the best available scientific information, NMFS cannot quantify the precise number of fish that are likely to be taken. Because both the number of shortnose 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

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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 shortnose sturgeon are aquatic species who spend the majority of their time on the 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, NMFS uses 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 shortnose sturgeon will be precluded from accessing provides a surrogate for estimating the amount of incidental take.

As explained above, the Veazie and Great Works projects together preclude shortnose sturgeon from accessing approximately 22km of upstream habitat, which is thought to represent the full extent of the historic range of shortnose sturgeon in this river system. The projects also limit the amount of low salinity habitat available for the development of larvae and juveniles to an approximately 16km stretch from Veazie Dam to Hampden. The extent of take will be limited to those areas above the Veazie Dam. As such, NMFS will consider take to have been exceeded if the operation of the Veazie Dam continues for more than 6 years following the issuance of the final FERC Order and the permits from the ACOE and/or if the proposed action does not result in the restoration of access to Milford Dam.

9.1.2. Project Decommissioning

Atlantic salmon

NMFS anticipates that Project decommissioning operations would harm adult Atlantic salmon during the dam removal process, predominantly through fish passage delays and exposure to elevated turbidity and sediments. No lethal take of shortnose sturgeon is anticipated. Rather, take of each species is likely to be in the form of behavioral responses resulting in fish passage delays or relocating to other areas of the river during construction activities. In addition, upstream and downstream fish passage at the Howland Project following license surrender is also not expected to result in any take of Atlantic salmon. This expectation will be verified by monitoring fish passage in Howland fish bypass. If monitoring indicates that an impediment to Atlantic salmon passage is present in the fish bypass, that would constitute take of the species and consultation would need to be reinitiated.

NMFS believes this level of incidental take is reasonable given the seasonal distribution and abundance of Atlantic salmon in the action area. In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy of Atlantic salmon. It is not possible to monitor the exact numbers of takes of Atlantic salmon occurring during decommissioning activities. In this instance, NMFS will assume that take of Atlantic salmon from decommissioning activities has been exceeded significant project delays occur. If the Great Works Project is not removed within 2 years following receipt of the necessary FERC orders and ACOE permits and the Veazie and Howland Dams are not removed within 6 years, than NMFS will assume exempted take levels for Atlantic salmon have been exceeded.

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Shortnose sturgeon
As explained in the "Integration and Synthesis" of effects section, as all effects of decommissioning activities on shortnose sturgeon are likely to be insignificant, no take of shortnose sturgeon from decommissioning activities is expected and therefore none is exempted.

9.2. Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of Atlantic salmon and shortnose sturgeon in the action area. Therefore, FERC should require the Trust complete 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 decommissioning 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.

9.3. Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, 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, FERC shall ensure that prior to dam removal (currently scheduled to begin in spring 2010), the Trust prepare a Final Dam Removal Construction Plan (Construction Plan) in collaboration with NMFS, USFWS, ACOE, and other state agencies.

2. To implement reasonable and prudent measure #1, FERC 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 decommissioning 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

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action or this incidental take statement may be authorized via simple amendment of this Opinion.

3. To implement reasonable and prudent measure #2, FERC and the ACOE must require the Trust to do the following:
   a. Timing of in-water work: Work below the bankfull elevation[11] 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 150 feet (46 m) 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 150 feet (46 m) 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 7 days.
   l. Place material removed during excavation only in locations where it cannot enter sensitive aquatic resources.

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11 'Bankfull elevation' means the bank height inundated by a 1.5 to 2-year average recurrence interval and may be estimated by morphological features such as average bank height, scour lines and vegetation limits.

m. Minimize alteration or disturbance of the streambanks 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 150 feet (46 m) of the edge of the bank to the greatest extent practicable.

4. To implement reasonable and prudent measure #3, FERC and the ACOE must require the Trust to do the following:

   a. Contact NMFS within 24 hours of any interactions with shortnose sturgeon, including non-lethal and lethal takes (Jeff Murphy: by email (Jeff.Murphy@noaa.gov) or phone (207) 866- 7379 or the Section 7 Coordinator by phone (978)281-9208 or fax 978-281-9394).

   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 mail (to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, , MA 01930).

5. To implement reasonable and prudent measure #4, the FERC 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 reasonable and prudent measure #4, 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 3 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

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federal resources agencies. Annual reports summarizing the results of the studies should be submitted to resources agencies by January 1 of each year during the 3-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 resources agencies by January 1 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 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.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep 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 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 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 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, #5, and #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.

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10. 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 endangered shortnose sturgeon or listed Atlantic salmon in the action area. As this project is intended to conserve and restore populations of Atlantic salmon and shortnose sturgeon, NFMS is not recommending any further conservation recommendations in this Opinion.

11. REINITIATION NOTICE

This concludes formal consultation concerning FERC's 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, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

This opinion assumes that interim operations will occur for no more than 6 years. If interim operation are required for a period greater than 6 years, FERC and the ACOE must reinitiate consultation with NMFS.

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ATTACHMENT A
FLOW DURATION CURVES AT VEAZIE, GREAT WORKS, AND HOWLAND DURING THE SPRING OUTMIGRATION PERIOD OF ATLANTIC SALMON

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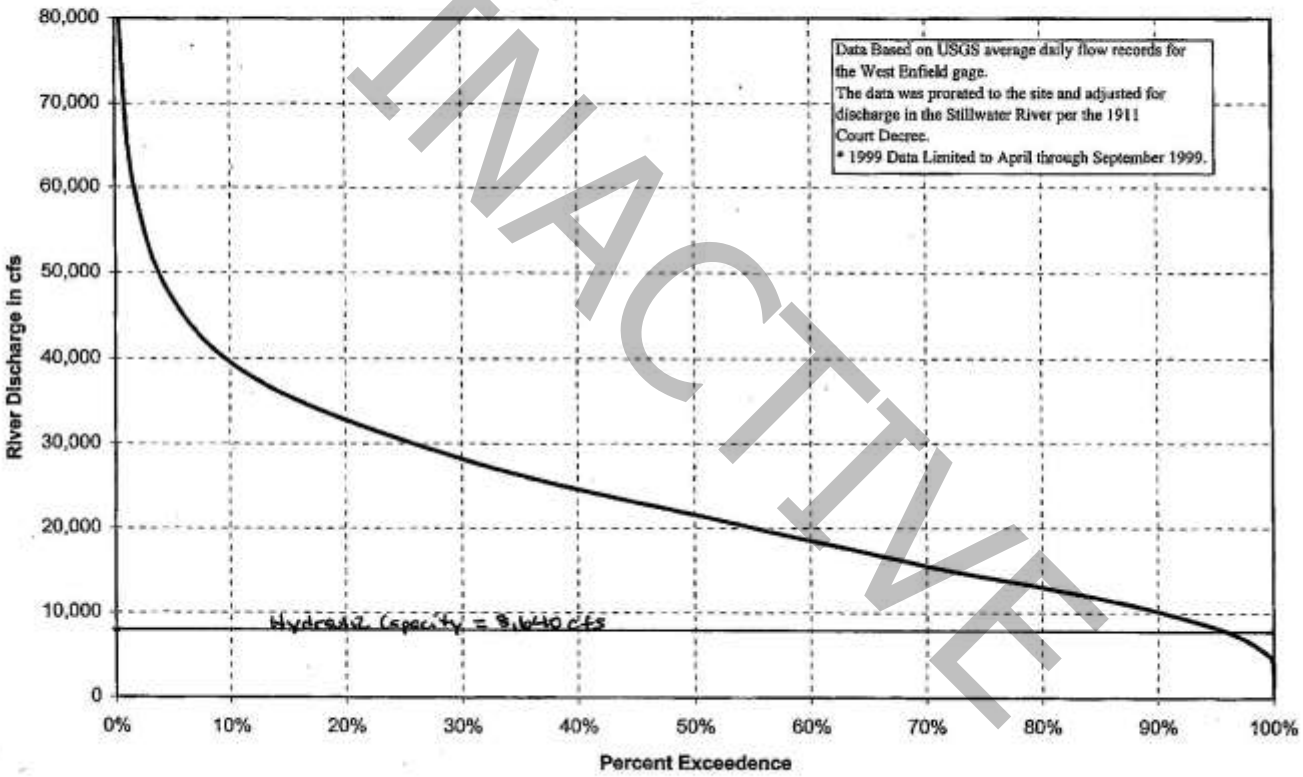
Great Works Project

April Flow Duration Curve

Penobscot River at Great Works Dam, Period of Record 1902-1999*



Great works Flow information 2.xls April 03/22/2000

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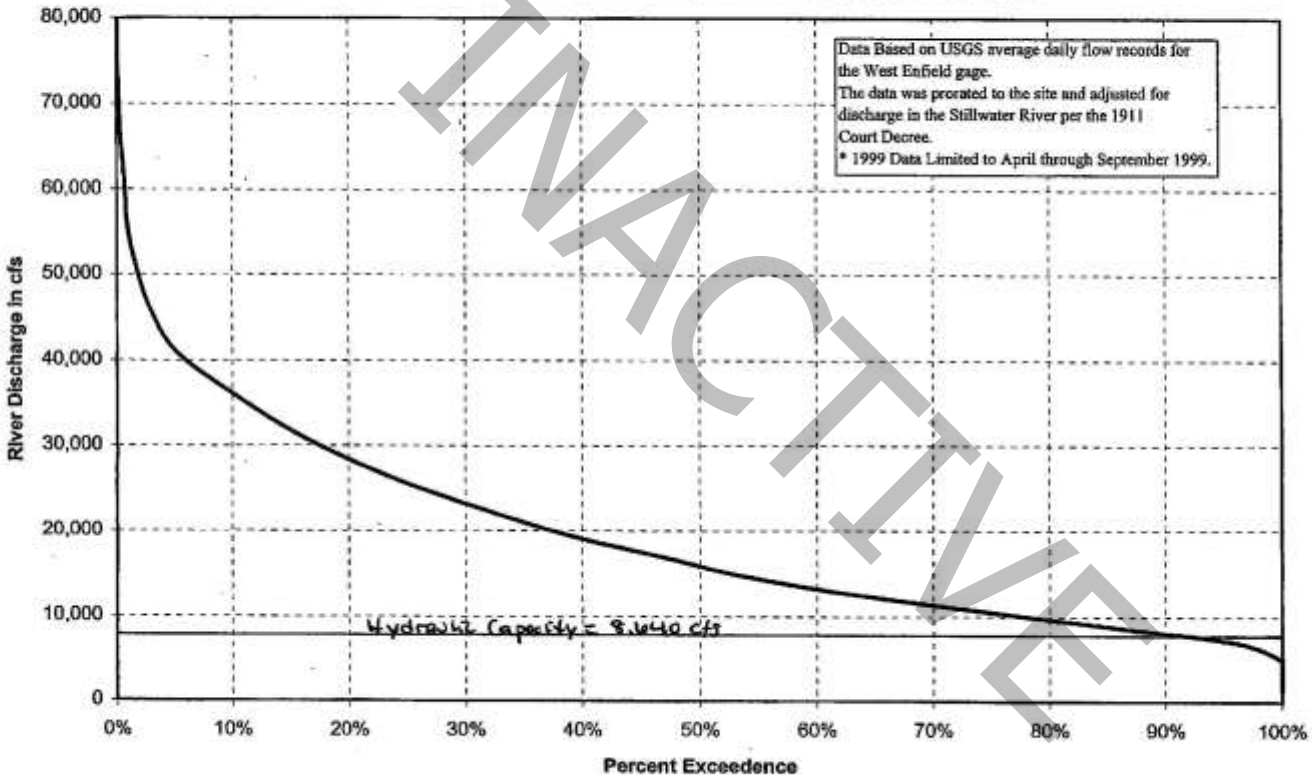
Great Works Project

May Flow Duration Curve

Penobscot River at Great Works Dam, Period of Record 1902-1999*



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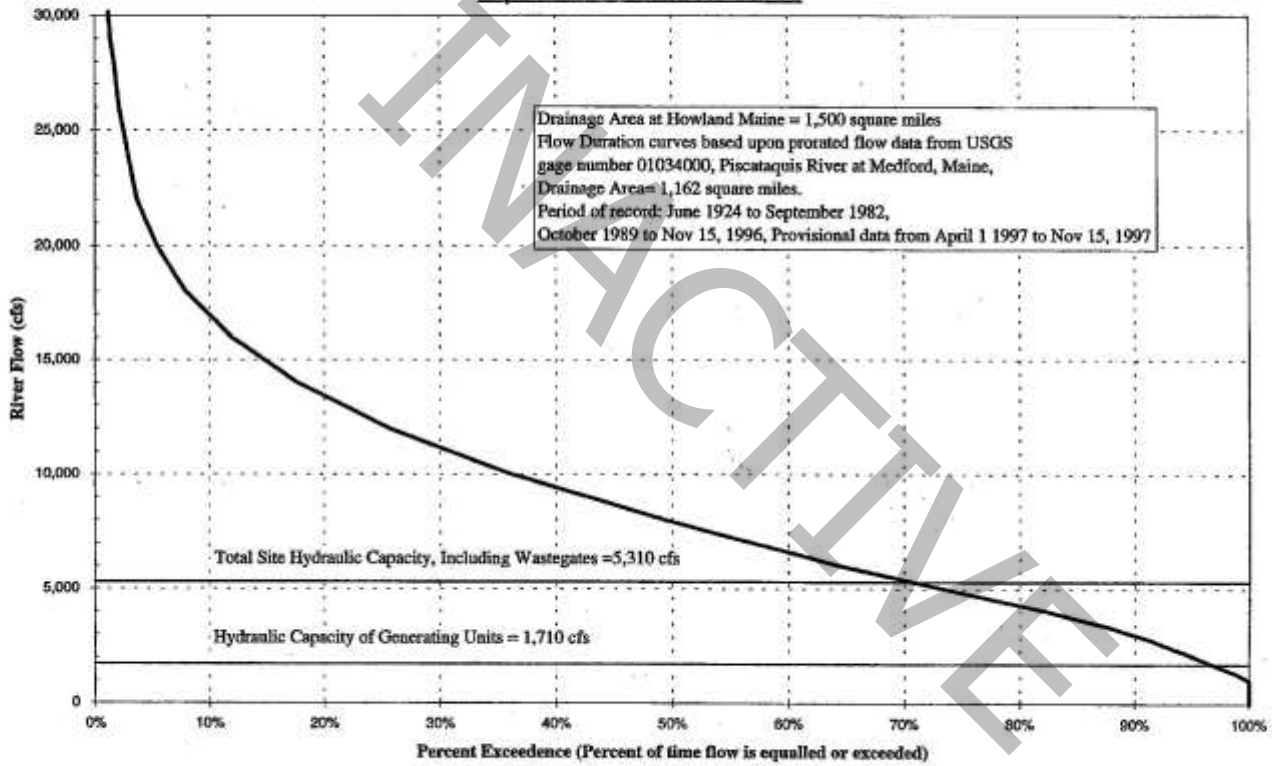
Bangor Hydro-Electric Company

Piscataquis River at Howland

April Flow Duration Curve



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April

Howland flow duration.xls 12/8/97 2:59 PM

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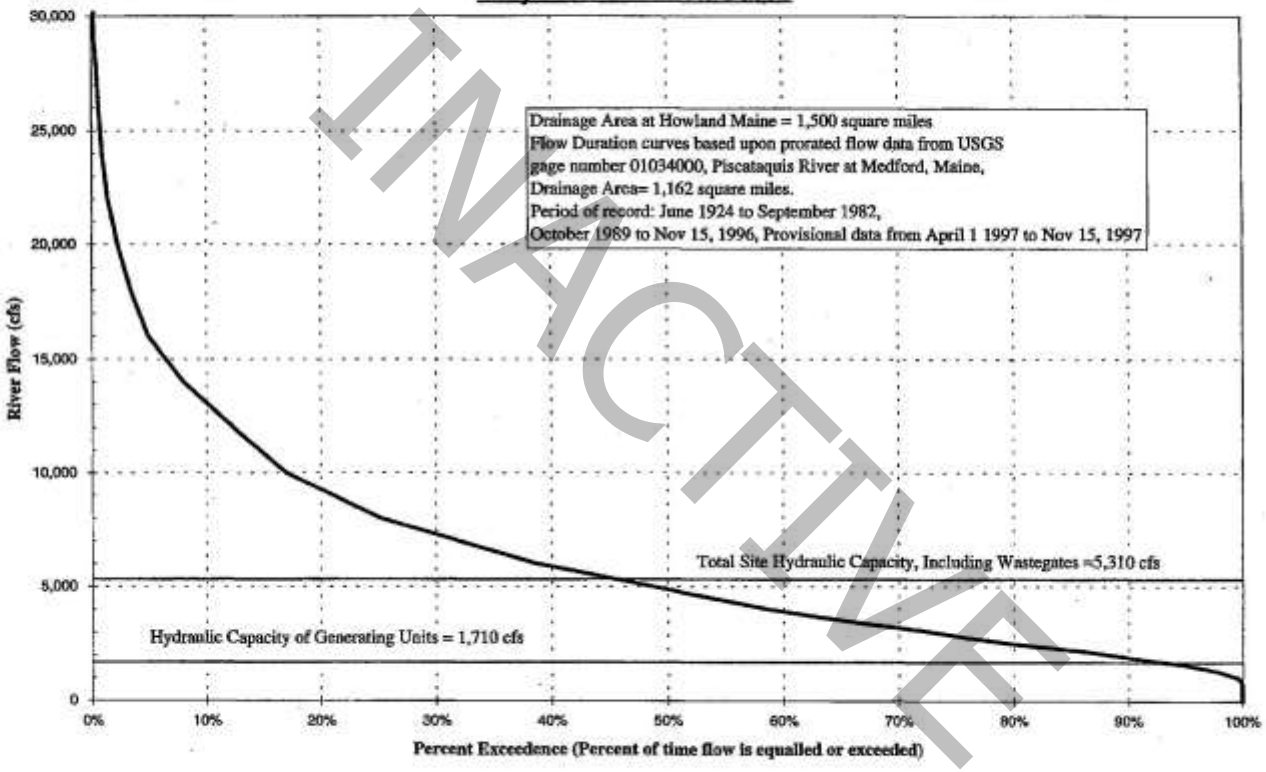
Bangor Hydro-Electric Company

Piscataquis River at Howland

May Flow Duration Curve



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May

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